SPGR Sub-Project Completion Report

On

Production of HYV Vis-a-Vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh

Duration: April 2010 to December 2013

Executing Organization
Department of Animal Breeding and Genetics
Bangladesh Agricultural University
Mymensingh

Submitted to
PIU-BARC, NATP: Phase 1
BARC Complex
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List of Acronyms and Abbreviations

AI	=	Artificial Insemination
ANOVA	=	Analysis of Variance
ADG	=	Average Daily Gain
BARC	=	Bangladesh Agricultural Research Council
BAU	=	Bangladesh Agricultural University
BAURES	=	Bangladesh Agricultural University Research System
BER	=	Bangladesh Economic Review
BLUP	=	Best Linear Unbiased Prediction
BV	=	Breeding Value
et al.	=	Associate
F_1	=	First Filial
FAO	=	Food and Agriculture Organization
FY	=	Fiscal Year
GDP	=	Gross Domestic Product
g/day	=	Grams per day
HYV	=	High yielding Variety
h^2	=	Heritability
Kg	=	Kilogram
Ml	=	Milliliter
Mt	=	Metric ton
N	=	Number
P	=	Probability
PEST	=	Prediction and Estimation
RCC	=	Red Chittagong Cattle
REML	=	Restricted Maximum Likelihood
SE	=	Standard Error
SMC	=	Sub-clinical Mastitis
SPGR	=	Sponsored Public Goods Research
SPSS	=	Statistical Package for Social Science
VCE	=	Variance Component Estimation
vis-à-vis	=	In relation to
viz.	=	As follows
×	=	Cross
>	=	Greater than
<	=	Smaller than
+	=	Addition
%	=	Percentage
-	=	Subtraction

Executive Summary

The sub-project working area was specified, digitized and a baseline study was conducted to assess the status of livestock (mainly cattle) with respect to available cattle genetic resources, breeding system, quality of breeding services, their production, reproduction, health status, management system and marketing system using an in-depth baseline survey. The mean of homestead land owned by the farmers was 36.17± 32.94 decimal and most of them (49.74%) own low category of homestead land (11-50 decimal). Average cultivable land owned was found as 101.52±61.044 decimal and a considerable number of farmers have medium (51-150 decimal) to high (151upward decimal) land area. From the collected data, it is clear that most of the households have cattle and chicken. But among cattle owners, about 80.06% have lower number (1-3). Straw was preferred by the farmers to feed their cattle which was about 84.9%, 84.44% & 81.48% for cow, heifer & bull, respectively. Most of the farmers use Deshi/locally available grass (96.8% for cow), whereas only 3.2 % (for cow) fed foreign grass. Among concentrates, wheat bran (29.6% for cow), oil cake (25.23% for cow), rice polish (18.38% for cow) are highly preferred. Milk sale and consumption (52.13%) was found as main objective behind cattle rearing. Semi-intensive method of rearing was found most acceptable (77.62% of cattle owners) among the peri-urban farmers. Disease problem was quite high because of lack of routine vaccination where vaccination was found to be practiced by only 38.46% farmers. Indigenous cattle are of high preference among the farmers because of its easy management and high resistance to disease. More than fifty percent farmers (52.45%) preferred Deshi cattle while 41.26% prefer crossbred cattle. Main reasons behind preference for Deshi cattle were easy management (24.48%) and lower feed requirement (12.59%) whereas, important reason behind crossbred preference (35.66%) was higher milk production. Artificial Insemination (AI) was preferred (61.06%) over natural service (38.94%). For artificial insemination, semen of Holstein Friesian (43.07%) was preferred where Deshi was the second most choice (39.41 %). Most of the farmers (82.9%) have no idea about genotype, quality & merit of semen. Average milk yield of Deshi and crossbred genotype were found as 1.72±0.80 and 6.65±5.05 liter per day respectively whereas lactation period and dry period were found respectively as 243.98±113.13 and 92.37±63.14 days in crossbred, 249.69±106.93 and 96.58±32.06 days in Deshi cows. The results of the study indicate that under semi-intensive peri-urban dairying system farmers have differences in choice of cattle breeds / genotypes and hence breeding service providers should make meritorious and quality semen available as per their choice to sustain dairy farming.

Elite (most productive) dairy cows and their owners in the project area were invited for repeated open consultations and meetings to assess their prime needs and the objectives of this project were ventilated among them. An agreement was reached with the farmers to participate in a seed bull production program in a contractual procedure. Two farmers' cooperatives were formed in two different corners of the project, Bade Kolpa and Chala Kandi. Trainings on scientific cattle husbandry and dairy production system were conducted for the elite cattle farmers of the project area. Elite cows and heifers (mother of future seed bulls) of various HYV and Deshi genotype were identified using ear tags and/or neck bands, registered and individual pedigree and performance recorded using Herd Book. Registered cows / heifers were bred with semen of high dairy merit and all registered animals were tested for major diseases e.g. mastitis, parasitic infestation etc on regular basis. Farmers training, routine vaccination and deworming of registered animals and their progeny were continued throughout the project period.

The prevalence of sub-clinical mastitis (SCM) in lactating cows was 55.1%. The highest prevalence of SCM was 84.4% in more than 7 years old cows. The prevalence of SCM was significantly ($P<0.001$) increased with the advancement of the age. The prevalence of SCM was significantly ($P<0.05$) higher (73.7%) in cows producing more than 15 liters of milk. Cows with 75% Holstein Friesian genotype

experienced more SCM (63.0%) than other genotypes. An increased prevalence of SCM with increased number of parity in cows was also observed. The prevalence of SCM was significantly ($P<0.001$) higher in cows with parity more than five. The highest prevalence of SCM was recorded in left front quarter (32.3%) but the difference was not significant ($P>0.05$) statistically. The efficacy of Neomastipra-JR5® as intra mammary infusion against SCM in lactating cows was 78.2%. Draminski mastitis detector could be a potential tool for the diagnosis of SCM in dairy animals of Bangladesh.

Six different modalities and management tools as treatments were applied on 158 registered cows: (1) Conventional practices or control group, (2) Cleaning of cow shed by disinfectant Vircon–S twice a week, (3) Using towel for cleaning udder of cows with potassium permanganate in luke warm water and without introducing calf to cow before milking, (4) Using towel for cleaning udder with antiseptic potassium permanganate in luke warm water without introducing calf with udder before and after milking, (5) Not allowing cow to touch udder into floor within 2 hours before and after milking and (6) Use of plastic mat in the floor of lactating cows. Out of 68 lactating cows, only 8 (11.76%) were affected by mastitis. The prevalence of sub-clinical mastitis in case of treatment 1, 2, 3, 4, 5 and 6 were 55.1, 13.3, 20, 0, 13.3 and 11.11% respectively. After modalities and management tools have been applied in the sub-project area, a significant overall reduction in mastitis (11.76% SCM) occurrence was observed. The analysis of variance showed significant ($P< 0.01$) differences in the prevalence of SCM among the treatments given to prevent mastitis. It revealed that the fourth and sixth intervention showed promising results in terms of preventing SCM**.** These results would help tropical dairy farmers rearing crossbred cows to choose appropriate intervention (management tool) to protect their cows better from SCM and thereby increase dairy profitability.

Evaluation of the genotype - environment interaction in growth traits of crossbred dairy calves in peri-urban system of Mymensingh district was carried out. Birth weight, three-month weight, six-month weight, weaning weight, average daily gain, testis size, scrotal circumference and survival rate up to six months of age of a total of 280 dairy crossbred calves reared in 103 households which were comprised of three different genotypes: Friesian-Local (75% HF), Friesian-Local (62.50% HF) and Friesian-Local (50% HF), two sexes: male and female and three seasons: rainy, winter and summer and two environments: E_1: Poor input system, and E_2: Good input system were used. The effects of sex, genotype and season were non-significant ($P>0.05$) on the studied traits. The average weight at birth in E_1 was 19.94 kg and E_2 were 31.06 kg. At three months of age in E_1 body weight was 53.85 kg and E_2 weight was 64.19 kg. Average six month weight in E_1 was 71.39 kg and in E_2 it was 98.86 kg. Weaning period in E_1 was 116.92 days and in E_2 it was 240.74 days. The average daily gain in E_1 was 487.59 g/day and in E_2 was 496.04 g/day. The highest mean birth weight (31.07 kg) was found in Friesian - Local (75 % HF) calves in E_2. The highest 3-month weight (64.19 kg) was found in Friesian - Local (75 % HF). The highest six-month weight (98.86 kg) was found in Friesian - Local (75 % HF) in E_2. The highest average weight was (240.75 kg) at weaning period. The highest average daily gain (320.57 g / day) was found in Friesian - Local (75 % HF) in E_2. The highest birth period testis size (4.96 cm), at three-month (9.02 cm), six-month testis size (11.33 cm),weaning period testis size(13.50 cm) were found in Friesian - Local (75 % HF) male in E_2.The highest daily growth of testis size 0.310 mm/day found in Friesian - Local (75 % HF) male in E_2. The highest birth period scrotal circumferences (7.68 cm), at three month (12.68 cm), six-month scrotal circumferences (18.06 cm), at weaning period scrotal circumference (20.10 cm) were found in Friesian - Local (75 % HF) male in E_2. The highest daily growth of scrotal circumferences 0.28 mm/day found in Friesian - Local (62.50 % HF) male in E_2. The highest survival rate was 100 % which was found in Friesian - Local (50 % HF) cattle in both E_1 and E_2. The results of the study indicated that Friesian-Local (75% HF) genotype performed significantly better in environment two (E_2) for most of the studied traits whereas Friesian-Local (50% HF) performed better in environment one (E_1) only for survival rate meaning their suitability and thereby posing non-significant genotype - environment interaction ($G \times E$) in the said

peri-urban condition of Mymensingh district. So, in E_2 Friesian-Local (75% HF) genotype and in E_1 Friesian-Local (50% HF) would be appropriate for use to realize maximum performance.

A total of 203 households, possessing 358 lactating cows were selected where two different management environments were applied: (i) Intervention (E_1) group and (ii) Non-intervention (E_2) group to study the suitability of temperate and tropical crossbred dairy cattle under peri-urban production system. There were a total of 158 registered cows from 58 households in E_1 and a total of 200 non-registered cows from 145 households in E_2. The available dairy crossbred genotypes were 50% Holstein Friesian (HF), 62.5% HF (5/8HF), 75% HF (3/4HF). Average daily milk yield was 8.11±0.24 kg, it is higher in 62.5% HF genotype (8.60±0.41 kg) compared to 50% HF (8.32±0.42 kg) and 75% HF (7.42±0.42 kg). However, the intervention group (E_1) was more efficient with an average of 9.85 ±0.39 than non intervention group (E_2) with 6.38±0.28 kg. The highest milk yield in 180 days was found (1550±74 kg) at 62.5 % HF and lowest (1339±76) at 75% HF genotype. Against, G×E interaction effects were not significant on total milk yield (TMY) and daily milk yield though effect of environment was highly significant ($P<0.001$). The shortest dry period was found in 50% (88.99±2.53 days) and highest in 75% HF cross cows (102.19±2.72 days). The shortest age at first heat was found in 50 % (28±0.28) and highest in 75% (36±0.29) months. The shortest age at fist calving was found in 50% HF (37±0.30) and highest was in 75% HF (44.99±0.32) month. The shortest calving interval was found in 50% HF (378±8.63) and highest was in 75% HF (437.80±10.53) days. Conception rate was found shortest (71±2.66) in 50% (and highest (80±2.52) in 62.5% Holstein Friesian crossbred cows. In case of reproductive performances (number of services per conception, conception rate, age at first heat, age at first calving, dry period, calving interval), genotype, environment and G x E interaction had highly significant effects ($P<0.001$). Therefore, it can be concluded that for reproduction, 50% HF crossbred cows and for production both 50% and 62.5% HF crossbred cows are suitable in small holder peri-urban dairying system.

Estimation of heritability and genetic evaluation for growth performance of 82 registered calves with known pedigree (sire and dam) were carried out. The heritability for birth weight, three-month weight, six-month weight and weaning weight were 0.40±0.09, 0.46±0.08, 0.39±0.12 and 0.50±0.12, respectively. Estimated high heritability values of body weights suggested that individual selection would be effective. The estimated genetic parameters were used to predict the breeding values of seed calves and they were ranked in order of their genetic merit to accomplish selection decision.

Male seed calves with known dairy merit (based on test-day milk records of registered cows) and reproductive profile of their mothers, own body weight, growth and health information and finally their breeding values for growth traits were placed before a "Seed Bull Certification Committee" to identify potential seed bulls for use in the dairy industry. Two ''Seed Calf Rallies'' held in the project area created very good awareness, knowledge and voice of farmers. Project published reports, bulletin, catalogues were disseminated among scientific community, Government authority, practitioners, cattle breeding service providers and farmers. A total of 24 (16 plus 8) young seed bulls in two batches were certified and declared suitable by the Seed Certification Committee for use in breeding and information catalogues were passed on to the cattle breeding service providers of the country. Finally, replication of this research and development work by existing cattle breeding service providers (Government, BRAC, Lal Teer etc.) of Bangladesh in different milk-shed areas of the country is envisaged.

1. **Sub-Project Title**: Production of HYV vis-à-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh

2. **Coordinator/Principal Investigator/Co-principal investigator**:

   Principal Investigator (PI): Professor Dr. A.K. Fazlul Haque Bhuiyan
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4. **Duration of the sub-project:** From 1 April 2010 to 31 December, 2013
5. **Date of Approval:** 31.03. 2010 (as per LOA)
6. **Total approved Budget (Tk.):** 94, 03,845/-

   Total fund received (Tk.): 84, 89,359/-

   Total fund spent (Tk.): 8130545/-

   Unspent/balance fund (Tk.): 358814/- (as at 31 December, 2013)

   Reason for the balance: Due to unavoidable reason some of the activities could not be accomplished.

7. **Justification of undertaking the sub-project**

Seed is one of the least expensive but most important factors influencing yields in whole agricultural sector. A gap exists between demand and supply of quality dairy seeds (bull, semen etc) and is considered as the major constraint in enhancing dairy productivity. The infrastructure and technical know-how at national level still lag far behind in quality and high merit seed bull production to support dairy industry of the country. Hence, production of quality and known merit dairy seed bull is a demand of time. But cattle seed production is inherently a long-term and complex phenomenon due to lengthy generation interval, larger population size, higher selection pressure, pedigree and performance recording and hence incurs huge cost. Alongside, farmers are the principal custodians of cattle population of the country and therefore attempt to produce seed bull through active participation of the farmers is justified and economic.

8. **Sub-project objectives**

The main vision of the project was to "Lead the cattle farmers with genetics and knowledge to create wealth" with the following objectives:

(i) to develop a science-led farmer participatory system for seed bull production and
(ii) to ensure supply of meritorious and clean seed bull to the dairy industry of the country.

9. Methodology followed in conducting research/investigation

9.1. General Methodology

In this project research was carried out to establish Herd Book recording system for the production of meritorious breeding bulls in close cooperation with the cattle raisers of the project area. Farmer participatory Herd Book recording system, developing milk recording and genetic evaluation system, identification of young seed bulls, progeny show, preferential mating plan and replacement of AI breeding males with superior ones on regular basis for use in the farmers' herd were the main features of the project. However, the project methodology included the following steps : i) Baseline Survey, ii) Identification of Superior Cattle Genetics in Project Area (crossbred vis-à-vis indigenous), iii) Farmer Consultation and Contractual Agreement with Elite Farmers, iv) Farmers' Need Assessment and National Workshop, v)Opening Herd Book and Registration of Elite Cows, vi) Farmers' Training, Routine Deworming and Vaccination Program, vii)Breeding Through AI Using Superior Dairy Genetics (crossbred / indigenous), viii)Calf Identification and Registration, ix) Milk Recording, x) Animal Database Management and Genetic Evaluation, xi) Identification of Superior Young Bulls (crossbred / indigenous), xii) Testing Young Bulls for Diseases and Breeding Soundness , xiii) Organizing Progeny Show, xiv)Certification for Meritorious Young Seed Bulls and xv)Seed Bull Offer Among Cattle Breeding Service Providers. A brief description on each of the steps is given below.

9.1.1. Baseline Survey

The approach of the baseline survey is mainly based on field reconnaissance. A field reconnaissance has been done in different parts of Mymensingh Sadar and some parts of Gauripur upazila of Mymensingh district. In the field reconnaissance, the actual field situation was assessed by field visit of project personnel. Exchanges of opinions and views were carried out to identify the present status, problems and potentialities of rearing cattle. Finally, the areas which have been selected are Boyra, Ghagra, Vabokhali, Akua, Khagdohor, Dapunia, Char Ishwardia, Char Nilakshmia and Vangnamari union (Fig. 1).

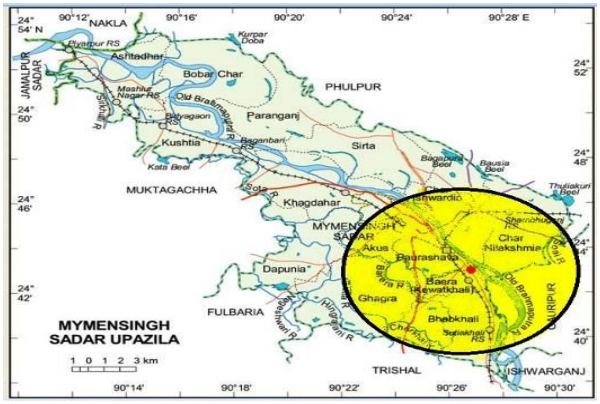

Fig. 1: Map showing project area with BAU AI Centre at its centre

9.1.2. Identification of Superior Cattle Genetics in Project Area

Based on survey information, superior cows & heifers were identified based on their previous performance & reproductive cleanliness. A pre-tested In-depth questionnaire (Appendix 1) was used to collect detailed biological information of individual animals. Collected in-depth data were compiled, analyzed and decisions were made to be an elite cow and heifer. A total of 158 such animals were identified through door to door search which were high producing elite (Fig. 2) cows and heifers (mother of probable future seed bulls) of various HYV and Indigenous genotype in the project area.

Fig. 2: Photograph of registered elite cows

9.1.3. Farmer Consultation and Contractual Agreement with Elite Farmers

Farmers owning elite animals in the project area were invited to series of open discussions and consultation meetings (Fig. 3) and a general agreement as to their willingness to participate in the seed bull production in a contractual system was reached. Most of farmers agreed and finally a total of 62 farmers were involved to this participatory seed bull production process.

Fig. 3: Consultation with farmers

9.1.4. Farmers' Need Assessment and National Workshop

9.1.4.1. Farmers Need Assessment

Baseline survey indicated that about 97.83 % of the respondents expressed their need for training on various aspects of cattle production. Among the respondents, 33.09 % raised their training need on general livestock management, 42.45% on dairy cattle husbandry, 18.71% on treatment and disease management, 0.72 % on production of quality seed, 2.16 % on fattening of cattle and 2.88 % on feeding management. Baseline survey also indicated that almost all respondents (99.27%) showed positive response towards developing a farmer participatory seed bull production system. Further, almost all of them (99.27 %) were interested in forming a Society for Seed Bull Production. Lack of managerial proficiency was identified as one of the important causes of less productivity of their dairy cattle.

9.1.4.2. National Workshop

A National Workshop (Fig. 4) on Production of HYV vis-a-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh was held on Tuesday, 27 December, 2011 at 11.00 AM at the

Conference hall of Animal Husbandry Dean Office, Bangladesh Agricultural University, Mymensingh. Principal Investigator of the project welcomed everybody in the workshop and in welcome speech he highlighted the background, farmers' as well as the country need of the project followed by an elaborate & in-depth paper on road-map of the project. Discussion on the presented paper was participated by Director BAURES, Dr. Md. Abul Kashem and Mr. Anwarul Iqbal, PIU-Bangladesh Agricultural Research Council, Dr. Shah Md. Ziqrul Haque Chowdhury, CSO (Livestock), BARC. Mr. Uttam Kumar Dutta, BRAC Bull Station, Mymensingh, BRAC, Professor Dr. Md. Abul Hashem Dept. of Animal Science, Dr. Md. Abdul Karim, AD-AP Mymensingh, farmers of the project, Mr. Md. Abdul Quddus, Mr. Nur Mohammed and Shamsun Nahar . Professor Dr. Md. Rafiqul Hoque, Vice Chancellor, BAU, Mymensingh asked the farmer that were they getting proper guidance from on-going project activities. The farmers informed that they were provided by the research team deworming, vaccination, good quality semen and scientific knowledge about livestock management. Professor Dr. Md. Rafiqul Hoque, Vice Chancellor, BAU and Chief Guest of the workshop highly admitted the project concept & methodology being followed. He also said "we all know that breed or seed is the basic input in livestock and productivity which is largely influenced by timely availability of quality seeds to the farmer. The gap between demand and supply of quality seeds is considered as major seatback in enhancing productivity. Hence production of good quality Dairy seed bull is essential in the country". He further in a cross -talk with the farmers enquired about the benefit they will get, how to continue those after project will be over. Chairman of the workshop, Dr. M.A. Samad Khan, Dean of the Faculty of Animal Husbandry thanked all attending members and felt his deep satisfaction on the project work. He also wished every success of the valued project. Finally, Professor Dr. S.M. Bulbul, UGC Professor thanked all participants for attending workshop and expressed his satisfaction about the progress made by the need based project work and closed the workshop. Finally, the workshop was concluded with the following decisions: (i) valued project should continue its good work, (ii) arrangements should be made so that the project is continued for longer period, (iii) the project should extend its working area all over the country (if possible) and (iv) two portable milking machines may be set under two farmer cooperatives for farmers' benefit.

Fig 4: National Workshop of the project

9.1.5. Opening Herd Book and Registration of Elite Cows

To collect pedigree and performance data on each and every identified animal and their progeny generation after generation, animal recording system is an essential component in any breeding program. Therefore, ear tagging and neck banding were done to identify elite animals individually. The book on which such records are officially registered is called "Herd Book" which was opened for every registered cows / heifers in the sub-project area. Herd Book containing detail information (e.g. ID no., date of birth, sire, dam, date of maturity, production performance, reproduction efficiency, disease incidence, vaccination schedule etc) of an animal was recorded in written form. Repeated

hands-on trainings (Fig. 5) on the importance, contents and methods of maintaining Herd Book (Fig. 6) were arranged for both the Animal Recorder and the farmers.

Fig. 5: Farmers in Herd Book training program

Fig. 6: Herd Book used for keeping animal records

9.1.6. Farmers' Training, Routine Deworming and Vaccination Program

The farmers owning elite registered animals were continually trained on scientific and profitable methods of dairy farming and cattle management. Training on scientific cattle husbandry, record keeping and dairy production system was offered to the elite cattle owners. Copies of "*Cattle Rearing Manual"* was prepared and distributed among the farmers as ready reference. Capacity building of a total of 210 farmers in a total of 4 training sessions were conducted from the project. All the registered cows, heifers and calves were provided with deworming agents routinely and before and after deworming feaces were examined. In addition, a scientifically scheduled vaccination program (Fig. 7) was followed to keep the registered animals disease free. Milk samples were also collected for conducting mastitis test (Fig. 8). Vaccination and deworming schedule followed in project area is presented in Table 1. Further, blood, feces and milk of the registered animals of the project area were routinely tested for investigating their health status and accordingly medicare was provided.

Table 1: Vaccination and deworming schedule

Measures	Name	Duration of treatment	Common drugs used
Vaccination	Anthrax, Black Quarter (BQ)	Half yearly	GOB available vaccine
	Foot & Mouth Disease (FMD)	Half yearly	Bivalent & Trivalent strain (FMD Bangla—Fnf, Aftovet—Intervet, Aftovetpour-French
Deworming*	Liver fluke	Half yearly	Tetramisole+oxyclosanide (Endex®-Novartis; Tetranid®-Techno Drugs; Levanid®-Acme lab.)
	Round worm	Half yearly	Albendazole, Fenbendazole (Endokill® -ACI; Helmex®- Renata; Peraclear®-Techno drugs,)
	Endo+Ecto parasite	Half yearly	Ivermectin-1% (Cevamec® -ACI)

Fig. 7: Routine vaccination of registered animals **Fig. 8: Mastitis testing using milk samples**

9.1.7. Breeding through AI Using Superior Dairy Genetics (crossbred / indigenous)

Registered cows and heifers were inseminated with superior dairy genetics selected from government Directorate of Livestock Services (DLS) source whenever they came into heat. A total of 158 cows / heifers were inseminated using the following semen from the bulls given in Table 2.

Table 2: Semen of bulls used to breed elite cows/heifers

Bull number	Genotype	Level of Holstein inheritance	Source
14840	(L×F×F×F) × (L×F×F)	87.5 %	DLS
14837	(L×F×F×F) × (L×F)	75%	DLS
2954	(L×F)	50%	DLS
2936	(L×F×F×F) × F	75%	DLS
14804	(L×F×F×F) × (L×F×F)	87.5 %	DLS
14080	(L×F) × (L×F×F)	62.8%	DLS

DLS = Directorate of Livestock Services

9.1.8. Calf Identification and Registration

Eighty two calves were born, individually indentified, registered them according to breeding line and their detailed records on body weight, testes size and scrotal circumference (for males) at different ages were measured routinely (Fig. 9).

ww

Fig. 9: Calf identification and registration

9.1.9. Milk Recording

Test day milk yield data (morning and afternoon) were recorded in the presence of Animal Recorder. Test day (morning and evening) milk yield data were recorded on fortnightly basis. Moreover, all lactation parameters of elite cows were being recorded properly. Alongside, all other information demanded by the Herd Book such as pedigree, date of birth, weight at birth, age and weight at weaning and maturity, scrotal circumference, testis size, disease incidence etc were being recorded through periodic visit to farmers' home by Animal Recorder who maintained data with the assistance of animal owner.

9.1.10. Animal Database Management & Genetic Evaluation

Performance data on a total of 158 registered cows and 82 calves (males and females) were regularly updated. Separate files for registered cows and calves were maintained with each and every detail. Finally, accumulated data materials were used for estimation of variance components and prediction of additive genetic merit of animals using single trait Animal Models. For variance components VCE (Groeneveld, 1998) and for genetic merit PEST (Groeneveld et al, 1998) was used.

9.1.11. Identification of Superior Young Bulls

Six superior young bulls (02 Holstein crossbred, 02 RCC and 02 Munshigonj cattle) were identified, registered and brought to the BAU AI Centre (Figure 10) and subsequent tests for growth, infectious and venereal diseases, andrology (scrotal circumference and size of testis), semen quality and quantity were carried out.

Fig. 10: Identified superior young bulls at BAU AI Center

9.1.12. Testing Young Bulls for Diseases and Breeding Soundness

Potential young bulls in the project area were tested for infectious and venereal diseases, breeding soundness using parameters such as scrotal circumference, testes size, opening of penis, body weight changes with age etc.

9.1.13. Organizing Progeny Show

Two events of ***Seed Calf Rallies*** were organized using the project born pedigreed seed bull calves (of which Bade Kalpa Seed Calf Rally was held on 28.4.2012 (can be seen in Bdnational.com, 02 May, 2012 in link of http://www.mobile.bdcampusnews.com/index.php?s=5&news_id=2335) and Chalakandi Seed Calf Rally was held on 1.5.2012 (can be seen in The Daily Independent, Friday, 04 May 2012 in the link of http://theindependentbd.com/national/107793-fair-stresses-on-healthy-bull-in-mymensingh.html) for farmer and stakeholders' demonstration as well as awareness building. Judged by a panel of experts, prize was distributed among the good farmers.

Fig. 11: Seed Calf Rallies and prize distribution

9.1.14. Certification for Meritorious Young Seed Bulls

Potential candidate bulls selected based on the pedigree, weight, growth rate, body conformation, leg and hoof strength, scrotal measurements, parasitic load, disease incidence, semen quality and quantity, and dam's status on productive and reproductive potentials; particularly on milk yield, lactation length, conception rate, incidence of abortion, dystocia, TB and mastitis etc. Compiled information on each registered bull calf was submitted to the Livestock Seed Certification Committee (LSCC) for decision. Alongside, the results of genetic evaluation of candidate bulls were placed before the committee for decision and declaration.

9.1.15. Seed Bull Offer Among Cattle Breeding Service Providers

A total of 24 (16 plus 8) such candidate young dairy seed bulls in two batches were certified and declared suitable for breeding purposes by the Seed Certification Committee and information catalogue on the said two batches of bulls were passed on to the cattle breeding service providers (DLS, Milk Vita, BRAC, Lal Teer) of the country for necessary action.

Fig. 12: Monitoring & Evaluation Team at field visit

9.2. Experiment-wise Methodology

A total of six planned experiments were conducted during the project period and methodology of each of them is described below:

9.2.1. Practice, preference and performance of cattle under peri-urban dairy management system in Mymensingh

9.2.1.1 Place of Study

A field baseline survey was carried out in different parts of Mymensingh Sadar and some parts of Gauripur upazila of Mymensingh district. In the field reconnaissance, the actual field situation was assessed by field visits. Exchanges of opinions and views were carried out to identify the present status, problems and potentialities of rearing cattle. Farmers of Boyra, Ghagra, Vabokhali, Akua, Khagdohor, Dapunia, Char Ishwardia, Char Nilakshmia and Vangnamari union were selected for survey purposes. Distribution of households where baseline survey was conducted is presented in Table 3.

9.2.1.2 Preparation of Questionnaire

In order to fulfill the objectives of the baseline survey, a questionnaire was carefully prepared to collect the required data. The team members developed the draft questionnaire on the basis of field reconnaissance. The draft questionnaire was tested and was finalized after necessary correction, modifications and adjustments (Appendix 1).

9.2.1.3 Sampling Procedure

Stratified random sampling procedure was applied for selecting the samples for conducting baseline survey. There were a total of from 203 households located in 61 villages in fewer than 9 unions surveyed. From every village 2-3 households (HH) with cattle and 1-2 HHs without cattle (Non-cattle) was surveyed. The baseline survey was conducted by direct interview method during the period from 24th June to 07th July, 2010.

9.2.1.4 Method of Data Collection, Management and Analysis

For collecting the necessary data, the survey team explained to respondents about the aims and objectives of the baseline survey before going to make the actual interview. The respondents were assured that the information given by them would not be used against their interest and that it would be useful to the households themselves in many respects. Interviewees were requested to give correct information as far as possible. To ensure the quality of information the interview schedule was checked to ensure that information to each of the items had been correctly recorded. If there were any items overlooked and misunderstood or found contradictory, these were corrected through re-

interviewing them. All the collected data were uploaded in computer and compiled in single Excel file. These data were then rechecked referring filled questionnaire and analyzed in accordance with the objectives of the study. Data processing included field and office editing, coding and tabulation. The analysis was done using descriptive statistics like percentage, frequency distribution and mean where appropriate.

9.2.1.5 Quality Assurance

Discussion on the questionnaire prior to interview was arranged and necessary explanation and clarification was given by principal investigator. The senior team members monitored the interviews as well as provided specific feedback to the enumerators regarding interview (e.g. questioning style, use of probing questions, and approach to the respondents). As a follow-up to cross check survey enumeration, senior team members re-interviewed some of the sample households for checking the process followed by the data enumerators. The senior team members also checked all completed questionnaires on a daily basis to identify the missing information, ambiguous answers, digital errors, and provided feedback to the enumerators (if any).

Table 3: Distribution of households where baseline survey was conducted

Location	With Cattle	Without cattle	Total
Barera	23	9	32
Ghagra	15	5	20
Bhabkhali	17	8	25
Akua	19	9	28
Char Ishwardia	21	7	28
Char Nilakshmia	10	5	15
Khagdahar	16	6	22
Dapunia	02	1	3
Vangnamari	20	10	30
Total	143	60	203

9.2.2. Prevalence of Sub-clinical Mastitis in High Yielding Crossbred Cows Using Draminski Mastitis Detector

9.2.2.1 Study sites and duration

The study was conducted on crossbred dairy cattle in peri-urban dairy production system within seven kilometers around the Artificial Insemination Centre, Bangladesh Agricultural University, Mymensingh. Lactating dairy cows of the 78 registered farmers of the said area were included in this study. The study was carried out during the period from April, 2011 to May, 2012.

9.2.2.2 Study design and data collection

A total of 158 registered cows from 78 registered herds of the said area were ear tagged to identify them individually. Milk samples were collected from all of the registered cows and individual cow level data on age, milk yield, genotype and parity were recorded by using a pretested in-depth questionnaire.

9.2.2.3 Sub-clinical Mastitis test with Draminski mastitis detector

Milk samples from 4 quarters of the udders of one hundred fifty eight registered cows were tested with the DRAMINSKI machine (Figure 1) to detect sub clinical mastitis (SCM). The test was performed according to the instructions of the manufacturer. In brief, a minimum of 15 ml of the first portion of

milk was poured directly from the teat to measuring cup. Then the switch on button was pressed to read the result in unit. The result recorded and milk poured out and the steps repeated for other quarters. The electrodes needed to be cleaned with methylated spirits on a clean cloth or tissue, or similarly with kitchen detergent and rinse off after each quarter. A reading below 250 units was considered as the cut-off value for the subclinical mastitis using Draminski mastitis detector.

9.2.2.4 Treatment of SCM with intra mammary infusion using Neomastipra JR5 in lactating cows

All of the 87 SCM infected cows were treated with Neomastipra JR5 at 12 hours interval for 3 days in intra mammary route.

9.2.2.5 Statistical analysis

The association of sub-clinical mastitis with age, milk yield, genotype and parity was determined by chi-square test using SPSS-11.5 computer package program.

9.2.3 Effect of Non-genetic Interventions to Manage Mastitis in Dairy Cows

9.2.3.1 Study location and duration

The present study was conducted in crossbred dairy cows in peri-urban areas within seven kilometers around the Artificial Insemination Centre, BAU, Mymensingh. A trial was carried out in two Seed Bull Production Societies of Kolpa and Salakandi under the villages of Badekolpa, Nijkolpa, Salakandi, Fakira kandi, Bat tala and Kewatkhali villages of Sadar Upazila, Mymensingh during a period from May 2012 to April, 2013. The data of the present study were collected from the framework an on-going project titled "Production of HYV vis-à-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh".

9.2.3.2 Study design

A total of 226 (158 + 68) registered Holstein Friesian crossbred cows were ear tagged to identify them individually and grouped them into six treatment groups including control. In order to accomplish this study, 68 (sixty eight) registered cows were identified and grouped into five treatment groups. The parity of these randomly selected lactating cows varied from 1 to 6+ at different lactation stages and different level of milk production and all cows of the experiment were taken from the farmers' herds. In first group (control); conventional management practice was followed in 158 cows. In second group, 15 cows in 5 cow sheds were chosen for cleaning with disinfectant Vircon-S. The floor, wall and whole shed were sprayed twice a week. In third group, which was constituted of 10 cows, dry clean cotton towel was used to clean udder with antiseptic potassium permanganate and calf was not introduced to the cow before milking. A total of 10 cows constituted the fourth group. In the fourth group, towel was used for cleaning udder with antiseptic potash in slightly luke warm water and without allowing calf to cow before & after milking. In this case, calves were fed bottle milk and milk replacer. In fifth group, fifteen cows were taken and cows were prevented from touching the udder on the soil or floor till 2 hours before and after milking every time. The sixth group was comprised of 18 cows in 5 sheds for which plastic mats were used on the floor.

9.2.3.3 Feeding & management of experimental animals

Cows were reared in intensive system throughout the experimental period. Rice straw was supplied by the farmers as basal diet to feed their animals. Most of the farmers used locally available green grass. Among the concentrates given wheat bran, oil cake and rice polish were the highly preferred ones. On an average, every cow offered 2 to 5 kg mixed concentrate given twice daily. In this experiment, cows that yielded more than 10 but less than 15 liters of milk/day were included.

9.2.3.4 Statistical analyses

Statistical analysis of the observed number of animals under each intervention group was carried out using SPSS-11.5 computer package program for frequency estimation and chi-square value for testing significance test.

9.2.4. Genotype-Environment Interaction in Growth Traits of Dairy Seed Calves Under Semi-intensive Production System

9.2.4.1. Study sites and duration

The experiment was carried out in the dairy cattle herds of peri urban farmers around 6-8 kilometers radius of Bangladesh Agricultural University Artificial Insemination Centre, Mymensingh which included two upazilas (Mymensingh Sadar and Gauripur (partially), nine unions (Baera, Bhabkhali, Ghagra, Akua, Char Iswardia, Char Nilakhshmia, Vangnamari, Dapunia (partial), Khagdahar (partial) and a total of 61 villages. The experiment was carried out during July, 2010 to April, 2012.

9.2.4.2. Definition of production environments

Production environment in the study area was identified and stratified by criteria based on number of calves and level of concentrate feeding. In poor input system (E_1) the numbers of animals ranged from 1 to 3 where less than 500g/either no concentrate were supplied per animal per day. On the other hand, in good input system (E_2) the numbers of animals were more than 4 and usually more than 500 g concentrate were supplied per animal per day.

9.2.4.3. Source of experimental data

Data were collected from dairy farmers' herds using an in-depth monitoring of individual calves (mainly Holstein Friesian-local crossbreds of different grades) where two different production environments were in existence (i) Poor input system (E_1) and (ii) Good input system (E_2). From the study area a total of 103 households were selected on the basis of availability of Local and Holstein crossbred calves of different grades. The data were divided into 2 groups according to above mentioned criteria representing E_1 and E_2 respectively. Finally a total of 280 calves (141 in E_1 and 139 in E_2) were included in this study from two different production environments. The genetic constitution of the calves was 75% Holstein Friesian (HF)-25% Local, 62.5% HF-37.5% Local, 50% HF-50% Local, and 100% local. It was determined by the in-depth one-two-one interview regarding history of the animal's dam (registered cow) and bull, the external shape of animal and phenotypic characters (Annexure 1).

9.2.4.4. Estimation of genotype - environment interaction (G×E)

The G×E interaction in weight, growth performance, testicular development and survival rate of dairy crossbred calves were measured taking two environments into consideration described above. In this study, factorial analysis of variance (Mathur and Horst, 1994) using a linear model, with an environmental factor, a genetic factor and interaction effect between the two factors, was fitted with genetic and interaction effects as random effects.

9.2.4.5. Statistical analysis

The recorded data were entered into Microsoft Excel, then calculation of mean and standard error (SE) for each of the traits. Analysis of variance was done using GLM procedure under factorial design and means were compared using Statistical Package for Social Science (SPSS Statistics 11.5, 2002) program.

9.2.5. Suitability of Temperate and Tropical Crossbred Dairy Cattle under Peri-urban Production System in Bangladesh

9.2.5.1. Place of Study and Duration

This work was carried out at the peri-urban farmers' herds of Mymensingh district within seven kilometers around the Artificial Insemination Centre, Department of Animal Breeding and Genetics, Bangladesh Agricultural University (BAU) during April, 20110 to March, 2013

9.2.5.2. Source of Experimental Data

The research data of the present study were collected from an on-going project titled "Production of HYV vis-à-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh", supported by Department of Animal Breeding and Genetics, Bangladesh Agricultural University (BAU), Mymensingh from April, 2010 to March, 2013 to evaluate productive and reproductive performances of available Holstein Friesian (HF) crossbred. An in-depth data collection format (Appendix 2) was prepared for collecting information on individual cows (mainly Holstein – Local crossbreds of different grade) in the project area. A total of 203 households, possessing 358 lactating cows were selected where two different environments, viz: (i) Intervention group (E_1) - where year round inputs and services such as vaccination, de-worming (thrice in a year), AI using superior semen, fodder seeds and cuttings, necessary treatment, medicine, feces test, feeding and management advice, testing for tuberculosis (TB) and mastitis, management tools for mastitis control were provided on routine basis; and (ii) Non-intervention group (E_2)-where farmers provided their animals with conventional practices. From the study area a total of 158 cows were selected from 58 households on the basis of intervention group and a total of 200 non-registered cows from 145 households were taken in non-intervention group in E_2. Data on a total of 158 lactating cows were collected from Holstein Friesian x Local crossbred cows. All cows were registered and every cow had an ID number. Non intervention group was unregistered and cows had no ID number and management system was traditional.

9.2.5.3. Herd Book Opened

A small book, where detailed information (e .g. ID no. date of birth, sire, dam, date of maturity, production performance, reproduction efficiency, disease incidence, vaccination schedule etc.) of an animal was recorded in written form. Herd books were opened for every registered cows / heifers in the working area.

9.2.5.4. Farmer's Training

Training on scientific cattle husbandry, record keeping and dairy production system was offered to the elite cattle owners. Copies of "Cattle Rearing Manual" was prepared and distributed among the farmers as ready reference. Capacity building of a total of 210 farmers in a total of 4 training sessions were conducted to date. Repeated trainings on the importance, contents and methods of maintaining Herd Book were arranged for both the Animal Recorder and the farmers.

9.2.5.5. Feeding and Management Practices

Feeding and management practices followed at the farmers' herd were almost uniform throughout the year. Most of the crossbred animals were fed concentrate which were supplied twice / thrice daily in the morning and evening and composed of rice polish, wheat bran, bran of legumes and oil cakes. Among concentrates, wheat bran (29.6% for cow), oil cake (25.23% for cow), rice polish (18.38% for cow) are highly preferred. Rice straw was used as bulk basal feed with some green grasses and concentrates. Very few (around 5%) farmers' fed fresh fodder to their crossbred cows and road side grasses. It is also important to mention here that green grass supply was not on *ad libitum* basis because of the unavailability and seasonal fluctuations in the availability of green grass during different seasons of the year.

9.2.5.6. Milk Production Recording

Test day (morning and evening) milk yield data were recorded on fortnightly basis. Moreover, all lactation parameters of elite cows were being recorded properly. Alongside, all other information demanded by the Herd Book such as pedigree, date of birth, weight at birth, age and weight at weaning and maturity, disease incidence etc were being recorded through periodic visit to farmers' home by animal recorder who maintained data with the assistance of animal owner.

9.2.5.7. Daily Milk Yield

To get daily milk yield the whole lactation period was divided into start of lactation, peak of lactation and end of lactation with duration. Then the average daily milk yield was calculated using the following equation:

Total milk yield = $x_1y_1 + x_2y_2 + x_3y_3$

Where,

y_1= milk yield at the start of lactation

y_2= milk yield at the peak of lactation

y_3= milk yield at the end of lactation

x_1, x_2 and x_3 denote the interval lengths of the different stages of lactation (start, peak and end) and they were summed up to lactation length.

Adjusted daily mean milk yield = $\frac{\text{Total milk yield}}{(x1 + x2 + x3)}$

The average daily milk yield (DMY) of a cow was measured by:

$$180\text{DMY (kg)} = \frac{\text{Sum of all test day yield}}{\text{Number of test day records}} \times 180$$

$$\textbf{DMY} = \frac{\text{Total milk produced in lactation}}{\text{Total number of days in the given lactation}}$$

9.2.5.8. Data Structure

The number of records in various traits according to environment and genotype are presented in Table 4.

Table 4: Number of records in various traits according to environment and genotype

Trait	Environment		Genotype (%HF)		
	Intervention (E_1)	Non-intervention (E_2)	50	62.5	75
AFH (m)	197	150	117	131	99
AFC (m)	197	150	117	131	99
DP (day)	149	196	118	131	99
CI (day)	150	198	118	131	99
NSC (no.)	150	200	118	131	99
CR (%)	150	98	84	76	88
180DMY (kg)	75	140	74	78	67
DMY(kg)	75	140	74	78	67

AFH= Age at first heat (month), AFC=Age at first calving (month), DP=Dry period (day), CI= Calving interval (day), NSC= Number of service per conception, CR= Conception rate (%), DMY=Daily milk yield (kg)

9.2.5.9. Estimation of Genotype by Environment Interaction (G × E)

The G ×E estimation of age at first calving, number of service per conception, age at first calving, parity, dry period, calving interval, lower conception, milk yield, increased calf mortality, various diseases etc. in dairy crossbred cattle (between Local and Holstein Friesian) were measured taking two environments into consideration described above. In this study, factorial analysis of variance using a linear model, with an environmental factor, a genetic factor and interaction effect between the two factors, was fitted as random effect.

9.2.6. Genetic Evaluation of Seed Calves for Growth Traits

9.2.6.1. Place of Study

The experimental site was located at the peri-urban farmers' herds of Mymensingh district within 6-8 kilometers around the Artificial Insemination Centre, Department of Animal Breeding and Genetics, Bangladesh Agricultural University (BAU) which included one upazila (Mymensingh Sadar), nine unions (Baera, Bhabkhali, Dapunia and Khagdahar) and a total of 7 villages.

9.2.6.2. Source of experimental data and data recording system

The data were collected from registered and non registered farmers' herds and under the project titled "Production of HYV vis-à-vis Indigenous Seed Bulls to Support Smallholder Dairying in Bangladesh". The experimental animals were divided into two groups, 25% Local – 75% Friesian and 37.5% Local – 62.5% Friesian. For analysis of growth performance of 304 calves (both registered and non-registered) were taken into consideration. For genetic analysis of growth performance, 82 calves (registered) and their birth weight, three month weight, six month weight, weaning weight (9 month) were taken into consideration. Effect of sex, season of birth, year of birth, genotype of calves and dam's daily milk yield were considered. The three seasons were summer (March-June), rainy (July-October) and winter (November-February).

A small book where detailed information (e.g. animal ID No., date of birth, sire, dam, date of maturity, production performance, reproduction efficiency, disease incidence, vaccination schedule etc.) of an animal was recorded in written form. Herd Books were opened for every registered cows / heifers in the project area. Alongside, all other records demanded by the Herd Book such as pedigree, date of birth, weight at birth, age and weight at weaning and maturity, scrotal circumference, testis size, disease incidence etc. were recorded in a periodic visit of farmer's home by animal recorder who maintained data with the assistance of animal owner and finally, the data were stored in computers for subsequent analysis.

9.2.6.3. Traits under study

Traits included were birth weight, three-month weight, six-month weight, weaning weight and average daily gain (birth to six-month).

9.2.6.4. Statistical analyses

Data were analyzed using SPSS 16.0 2007 computer software to estimate simple means and standard errors. For estimating heritability (h^2), computer program VCE 4.2.5 (Groeneveld, 1998) was used. All analyses were done using a single trait animal model with Restricted Maximum Likelihood (REML) procedure where animal's additive genetic effect was the only random factor, with sex of calf, season of birth, genotype of calf and year of birth as fixed factor. Genetic evaluation of each and every calf was performed using the Prediction and Estimation program (PEST) of Groeneveld et al. (1998).

The animal model in matrix notation was: $Y = Xb + Za + Wc + e$

Where,

Y= Vector of observation

X, Z and W = Known incidence matrices associated with levels of b, a, c with Y.

b = Unknown vector of fixed effects (sex of calf, parity of dam, year of birth and season of birth)

a = Unknown vector of breeding values

c = Unknown vector of permanent environmental effect

e = Vector of residual effects.

10. Results and Discussion

Experiment wise results and their discussion are presented below:

10.1 Practice, preference and performance of cattle under peri-urban dairy management system in Mymensingh

10.1.1. Primary information of the farmers

Basic information of the respondents in the survey area is shown in Table 5. The mean of homestead land owned by the farmers was 36.17± 32.94 decimal and most of them (49.7%) own low category of homestead land (11-50 decimal). Average cultivable land owned was 101.52±61.044 decimal and a considerable number of farmers had medium to high land area. Farming experience is very important for successful farming and average farming experience was 25.36±23.75 years. The mean family size was 6.26±2.42 person, but most of the farmers (70.9%) had a large size family (6-10 persons).

Table 5: Primary information of the farmers

Primary information	Category	Total	HH	% of total	Mean ± SD
Homestead land (decimal)	Very low (0-10)	197	52	26.40	36.17±32.94
	Low (11-50)		98	49.74	
	Medium (51-150)		46	23.35	
	High (151-upward)		1	0.5	
Cultivable land (decimal)	Very low (0-10)	105	01	0.9	101.52±61.044
	Low (11-50)		29	27.62	
	Medium (51-150)		53	50.48	
	High (151-upward)		22	20.95	
Farming experience (year)	No experience (0)	203	49	24.1	25.36±23.75
	Moderate (1-15)		45	22.2	
	Medium (16-30)		35	17.2	
	High (31-upward)		74	36.5	
Family members	Low (0-2)	203	5	2.5	6.26±2.42
	Medium (3-5)		43	21.2	
	High (6-10)		144	70.9	
	Very high (11-		11	5.4	

HH, household; SD, standard deviation

10.1.2. Number of livestock

Table 6 describes information about number and different age groups of livestock reared by the farmers in the study area. From the collected data, it is clear that most of the households have cattle and chicken. But among cattle owners, about 80.06% have lower number (1-4). Most of the farmers

are not interested in goat rearing. But chicken is common, average number owned is 4.42±3.71 with an average of 5.29±5.10 chicks.

Table 6: Information about the number of livestock in the households

Species	Category	Different stages of livestock					
		Adult		Grower		Calf/Kid/Chick/Ducklin	
		%	Mean±SD	%	Mean±SD	%	Mean±SD
Cattle	No Cattle	8.72 (13)	2.21±1.68	22 (22)	1.56±1.40	10.85 (14)	1.83±1.43
	Low (1-4)	85.23 (127)		72 (72)		82.95 (107)	
	Medium (5- 10)	6.04 (09)		1106 (06)		6.20 (08)	
Goat	No Goat	14.93 (10))	1.69±1.62	19.05 (4)	1.90±1.87	27.03 (10)	1.59±1.46
	Low (1-4)	80.6 (54)		71.43 (15)		67.57 (25)	
	Medium(5-10)	4.48 (3)		9.52 (2)		9.52 (2)	
Chicken	No Chicken	12.03 (19)	4.42±3.71	25.37 (17)	3.63±3.14	35.78 (39)	5.29±5.10
	Low (1-5)	64.56 (102)		56.72 (38)		18.35 (20)	
	Medium (6-15)	23.4237)		17.91 (12)		45.88 (50)	
Duck	No Duck	15.46 (13)	4.26±3.70	27.54 (7)	4.38±4.03	27.59 (08)	4.93±4.64
	Low (1-5)	58.89 (53)		38.46 (10)		34.48 (10)	
	Medium (6-15)	26.67 (24)		34.62 (9)		37.93 (11)	

10.1.3. Types of cattle

The two different cattle genotypes were available in the project area which included crossbred (41.52%) and Deshi (58.48%). Each genotype was further categorized as milch cow, pregnant cow, breeding bull, male and female calf. Among the cattle owners, 31.59% had milking crossbreds with 28.83 and 16.26% of female and male calves, respectively. Whereas, among 143 respondents, 23.52% and 30.50% had Deshi milking cows and female calves, respectively. Among the bulls, 9.15% were Deshi and 7.36% were crossbred.

10.1.4. Objective of cattle rearing

Response from the cattle owners is presented in Figure 13. Among them, 52.13% were being reared for milk sale and consumption. The second important objective was selling of cattle as a business (31.19%). Besides these, there were other purposes as- cultivation of land, religious purpose, festival etc.

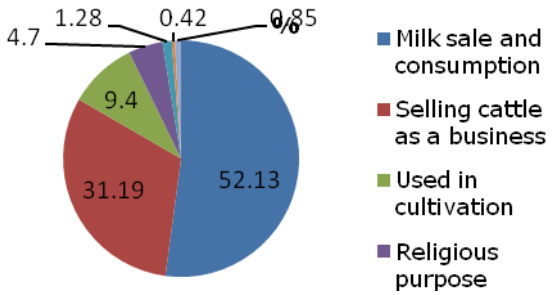

Fig. 13: Objective of cattle rearing

10.1.5. Rearing system of cattle

Around 77.62% of cattle owners followed semi-intensive method of rearing (Figure 14). In addition, rearing all types of cattle together (71.33%) was preferred than that of separately (6.29%).

Rahman et al. (2013) found that about 80%, 17% and 3% farmers reared cattle through semi-intensive, intensive and extensive or free grazing system, respectively which is very similar of these results.

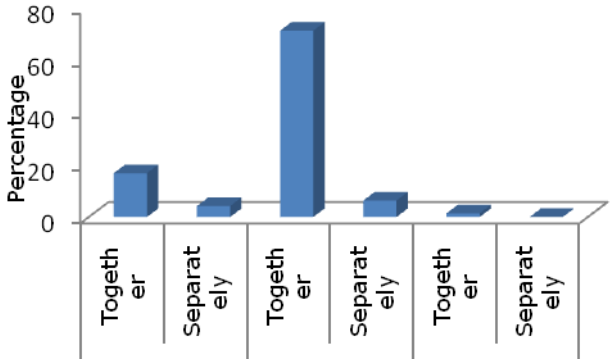

Fig. 14: Rearing systems of cattle

10.1.6. Type of feeds and amount offered

The types and amount of feeds offered to their cattle in study area are summarized in Table 7. Straw was preferred by the farmers to feed their animals which were 84.9%, 84.44% and 81.48% for cows, heifers and bulls, respectively. Most of the farmers used locally available grasses (96.8%) for their cows, whereas only 3.2 % farmers fed exotic grass to their cows. In case of concentrate, feeding of wheat bran (29.6%), oil cake (25.23%), and rice polish (18.38%) were preferred. On an average, 1 kg mixed concentrate feed/cow/day, whereas heifer & bull got 0.45kg and 0.27 kg /animal/day respectively. Rahman et al. (2013) found that more than 84% of the farmers managed feed from both sources (own and purchased) for their cattle even though 15% fully depended on purchasing feed from local market, but a little (1%) of them from their own sources which is very similar of this study.

Table 7: Type of feeds and amount offered to cattle

Feed types and amount	Category	Cow		Heifer		Bull	
		Frequency	%	Frequency	%	Frequency	%
Straw	Normal	113	84.9	76	84.44	44	81.48
	Treated	20	15.1	14	15.56	10	18.52
Grass	Deshi	121	96.8	78	95.12	49	94.23
	Foreign	4	3.2	4	4.88	3	5.77
Concentrate Feeding	Yes	73	51.05	39	27.27	32	22.38
	No	70	48.95	104	72.73	111	77.62
Concentrated feed ingredients	Wheat bran	95	29.60	55	27.64	44	30.78
	Oil cake	81	25.23	49	24.62	35	24.48
	Rice polish	59	18.38	43	21.61	29	20.28
	Broken rice	52	16.20	30	15.10	25	17.48
	Salt	30	9.35	17	8.54	7	4.90
	Others	4	1.25	5	2.51	3	2.09
	Fed/animal/ day(kg)	1.03		0.45		0.27	

10.1.7. Information about milk consumption and sale

Level of consumption of milk among the cattle owners was not so good; average consumption was only 1.18±0.88 liters daily, whereas average sale of milk by farmers was 8.86±24.62 liters daily. Average milk price in the surveyed area was Tk. 35.32±8.98 / liter. Milk selling channel was used by

most of the farmers through milkman. About 56.25% of the respondents sold milk by the help of milkman, whereas 28.75% farmers sold in retail on their own. But it was clear that a farmer could use more than one channel at a time. Most of the respondents (62.35%) were not happy with the price of their milk.

10.1.8. Different problems in Artificial Insemination

During survey in the area, farmers' response on different problems / constraints was considered. The main problems were lack of good semen, low pregnancy (conception) rate of cows / heifers, lack of inseminators, high price of breeding service and unavailability of AI service. Most of the farmers mentioned more than one problem in their dairy farming.

10.1.9. Breeding information

About 98.64% of the respondents reported that they breed their cows based on their observation of sign of heat of cows (Table 8). About 38.94% of the farmers still used natural breeding by bull, of which 58.87% bulls were Deshi type. Rahman *et al.* (2013) found that most of the farmers (76%) inseminated their cows artificially rather than naturally (19%) and merely of 5% did both, which is not similar of this study. The main AI service providers were government, BRAC and BAU AI center. BAU AI center provided service to about 61.36% of the total breed able cows in the surveyed area. Most of the farmers (82.9%) had no knowledge about good (merit and quality) seed or semen.

Table 8: Breeding information

Breeding information	Category	Frequency	%
Sign of heat	Shown	218	98.64
	Silent	3	1.36
Type of service	Bull/Natural service	88	38.94
	Artificial Insemination	138	61.06
Sources of Seed for A.I	Seed from Government	22	25.0
	Seed from BRAC	12	13.63
	Seed from BAUAI Centre	54	61.36
How farmer get AI services	Cows go to AI center	30	60.0
	By inseminator at home	20	40.0
Genotype used in natural service	Deshi	73	58.87
	Cross breed	51	41.13
Genotypes used in AI	Holstein Friesian crossbred	59	43.07
	Sahiwal	20	14.60
	Deshi (Red Chittagong Cattle)	54	39.41
	Others	4	2.92
Knowledge about good seed	Yes	33	17.10
	No	160	82.90

10.1.10. Information about disease and disease management

Disease management was cited as one of the important pre-requisite of successful cattle rearing. Still a large number of farmers (59.44%) were not attached to vaccination program. Vaccination for BQ, Anthrax and FMD were common (Table 9). About 41.96% of farmers reported death of cattle in last five years. Major causes of death were FMD and Anthrax. Farmers call registered veterinarian and quack almost in same proportion of 45.45 and 44.06 %. Mean of de-worming per year was found 1.92±1.41.

Table 9: Information about status of disease management

Case	Category	Frequency	%
Vaccination	Yes	55	38.46
	No	85	59.44
Types of vaccination done	Black Quarter	23	29.11
	Anthrax	26	32.91
	Foot and Mouth Disease	29	36.71
	Septic Throat	1	1.27
Cattle death in last 5 years	Yes	60	41.96
	No	77	53.85
Causes of death	Black Quarter	3	5.88
	Anthrax	11	21.57
	Foot and Mouth Disease	15	29.41
	Septic Throat	2	3.92
	Bloat	7	13.72
	Others	13	25.50
Veterinary services	Registered veterinary doctor	65	45.45
	Village Quack	63	44.06
	Drug seller	4	2.80
	Others	2	1.39
Deworming of cattle (no./year/herd)	1.92 ± 1.41 (Mean ± SD)		

10.1.11. Cattle preference and reasons behind this preference

Farmer's preference towards genotype and reasons behind this preference is very much important for taking decision. More than fifty percent farmers (52.45%) preferred Deshi while 41.26% preferred crossbred (Table 10). Main reasons behind preference for Deshi were easy management (24.48%) and lower feed requirement (12.59%), whereas important reason behind crossbred preference (35.66%) was their higher milk production. Rahman et al. (2013) found that the cow genotypes, more than half (61.16%) was of the indigenous which was significantly ($P<0.01$) higher than the crossbreds (38.84%) which is very similar of this study.

Table 10: Cattle preference of the farmers and reasons behind

Category		Pure Exotic		Crossbred		Deshi	
		HH	%	HH	%	HH	%
Overall Cattle preferences		9	6.29	59	41.26	75	52.45
Reason Behind Preference	High milk production	6	4.20	51	35.66	5	3.50
	High milk price and profitable	3	2.10	12	8.39	4	2.80
	Milk quality high or tasty	0	0	1	0.70	7	4.90
	High growth rate and tasty meat	0	0	5	3.50	4	2.80
	Regular calving	0	0	1	0.70	6	4.20
	Easy management or rearing	0	0	3	2.10	35	24.48
	Low rearing cost	0	0	0	0	9	6.29
	Low feed requirement	0	0	1	0.70	18	12.59
	Less disease risk	0	0	1	0.70	9	6.29
	Low space needed	0	0	0	0	3	2.10
	Ploughing	0	0	1	0.70	7	4.90
	Nice looking	0	0	2	1.40	3	2.10
	Best among all	0	0	0	0	6	4.20

10.1.12. Performance of different cattle genotypes

The lactation period of crossbred and Deshi cattle were 257.5 and 249.69 days, respectively (Table 11). The dry period was found higher in Deshi cattle (96.58 days) as compared to crossbreed (92.37 days). Mean dry period found in all cattle types was within normal range (<120 days). Generally, Deshi cows were milked once in a day, whereas crossbreds were milked more than single time. The average milk yield and lactation length of Deshi cows were 2.33±0.96 liters/d and 249.69±106.93 days, respectively. Conversely, the average milk yield and lactation length of crossbred cows were 9.72±6.50 liters/d and 243.98±113.13 days, respectively. Rahman et al. (2013) found that the average milk yield and lactation length of indigenous cows were 2.37±0.26 kg/d and 276.56±19.17 days, respectively. Conversely, the average milk was 9.33±2.44, 3.00±0.38, 3.16±0 and 2.25±0.25 kg/d for Holstein x Local, Sahiwal x Local, Sindhi x Local and Chittagong x Local cows, respectively. The average lactation length was 326.39±19.34, 306.28±25.52, 267.56±26.51 and 260.18 ±14.52 days for Holstein x Local, Sahiwal x Local, Sindhi x Local and Chittagong x Local cows, respectively.

Table 11: Performance of different cattle genotypes

Cattle Type	Mean ± SE					
	Daily milk yield (litre)	Lactation period (day)	Dry period (day)	Parity	Number of milking/day	Average highest milk production (litre)
Crossbred	6.65±5.05 (89)	243.98±113.13 (88)	92.37±63.14 (65)	2.63±1.44 (67)	1.56±0.49 (90)	9.72±6.50(89)
Deshi	1.72±0.80 (103)	249.69±106.93 (101)	96.58±32.06 (76)	2.85±1.66 (105)	1.03±0.16 (108)	2.33±0.96 (105)

*Case numbers are given in parentheses

10.1.13. Reproductive performance of different genotypes of cattle

Parameters related to reproduction were studied in both Deshi and crossbred cows which are presented in Table 12. Some cases of reproductive problems were found, but their frequency was not so significant.

Table 12: Reproductive performance of cattle of different genotypes

Characteristic	Mean ± SE				
	Deshi	50% HF-50% D	62.5% HF-37.5% D	75 % HF-25% D	50% SL-50% D
Number of services per pregnancy	1.21±0.01 (85)	1.54±0.02 (59)	1.34±0.01 (59)	1.40±0.01 (73)	1.38±0.05 (16)
Age at first heat (month)	32.00^{ab} ±0.13 (26)	25.29^{a} ±0.38 (17)	29.60^{ab}±0.92 (10)	24.23^{a} ±0.44 (22)	33.00^{b} ±0.60 (06)
Age at first calving (month)	41.13±0.15 (24)	36.43±0.49 (14)	41.00±0.89 (10)	36.63±0.53 (19)	41.40±0.66 (05)
Calving interval (month)	13.47±0.02 (70)	13.70±0.07 (30)	13.14±0.05 (44)	13.31±0.04 (51)	14.17±0.20 (06)
Post-partum heat period (day)	108.08^{b}±0.99 (52)	93.72^{a}±0.91 (39)	94.38^{a}±1.14 (48)	88.95^{a}±0.90 (59)	134.63^{b}±5.75 (08)
Dry period (day)	148.64^{d}±1.60 (33)	92.95^{ab}±2.43 (21)	74.48^{ab}±1.73 (23)	54.90^{a}±0.55 (31)	140.00^{cd} ±11.55 (3)
Abortion (avg. cases)	00	23.08% (03)	46.15% (06)	23.08% (03)	7.69% (01)
Retained placenta (avg. cases)	00	31.25% (05)	37.5% (06)	25.0% (04)	16.67% (01)

D=Deshi, HF = Holstein Friesian, SL=Sahiwal, figures in the parenthesis indicate number of observations, means with different superscripts within a row for a characteristic are significantly different (P<0.05)

The findings of the present study revealed the existing cattle rearing practices under peri-urban system of management which were more or less in line with similar production environments. The breed/genotype preference had found to be in accordance to their management level. Deshi was the choice of low input farmers and crossbreds were the choice of high input farmers. The reasons behind preference for Deshi were easy management and lower feed requirement, whereas important reason behind crossbred preference was their higher milk production. These findings corroborate with that of Rahman *et al.* (2013) where more than half (61.16%) like indigenous which was significantly (P<0.01) higher than the crossbreds (38.84%). However, in the present study 43.07 % farmers used HF crossbred semen while the degree of choice of Sahiwal and Red Chittagong semen by the farmers were 14.60% and 39.41% respectively. Important information to note from this study was that 82.90 % farmers had no knowledge about good seed or semen meaning that farmers used semen for breeding through AI without any information about the merit of semen. In general, it could be due to poor awareness among the farmers in this regard. These results therefore supports the findings of Jabbar et al. (2010) in Bangladesh who suggested to stop current chaotic AI delivery and a combination of different strategies for breed improvement should be adopted and breeding research, development and service delivery need to be designed taking cognizance of perspectives of experts and farmers.

10.2. Prevalence of Sub-clinical Mastitis in High Yielding Crossbred Cows Using Draminski Mastitis Detector

10.2.1. Prevalence of SCM

The study was carried out on 78 smallholder dairy farms. A total of 632 quarter milk samples from 158 lactating cows were examined by DRAMINSKI mastitis detector. The overall prevalence of SCM in lactating cows was 55.1% (Table 12). The reported prevalence of SCM varied from 15.8% to 53.1% in crossbred cows in Bangladesh (Prodhan *et al.,* 1996; Kader *et al*., 2002; Rahman *et al.,* 2009; Rabbani and Samad, 2010; Rahman *et al.,* 2010). The variation in reported prevalence of SCM might be due to difference of breed, management systems and test used for the diagnosis of this disease. All lactating cows in our study were HF cross and the result was slightly higher than other studies.

The highest prevalence of SCM was 84.4% in more than 7 years old cows. The prevalence of SCM was significantly (P<0.001) increasing with the advancement of the age (Table 1). This finding corroborates with Neelesh *et al.* (2012). Higher prevalence of SCM in older cows might be due to the fact that the teat canal in older animals was more dilated or it remains partially open permanently due to years of repeated milking (Madut *et al.,* 2009). It also encourages the introduction of environmental and skin-associated microorganisms into the teat canal, leading to SCM in cows (Karimuribo *et al*., 2008).

The prevalence of SCM was also significantly (P<0.05) higher (73.7%) in cows producing more than 15 liters of milk (Table 13). Islam *et al*. (2010) also reported similar findings. The prevalence of SCM varied with the genotype. Cows with 75% HF genotype experienced more SCM (63.0%) than other genotypes (Table 12). Although statistically insignificant, an increasing trend of SCM was noted with the increased percentage of genotype. Biffa *et al*. (2005) reported that Holstein-Friesian cows were more frequently affected (56.5%) than local zebu (30.9%) and Jersey cows (28.9%). Sharma and Maiti (2010) also found that Holstein-Jersey crossbred cows were at higher risk (94.54%) for mastitis than local zebu cows (31.25%).

An increased prevalence of SCM with increased number of parity in cows was also observed. The prevalence of SCM was significantly (P<0.001) higher (78.4%) in cows with parity more than five (Table 13). Similar findings were also reported by other authors such as Sharma *et al*. (2007) and Sharma and Maiti (2010).

10.2.2. Quarter-wise Prevalence of Subclinical Mastitis in lactating cows

The quarter-wise prevalence of SCM was 32.3% in left front, 24.1% in left hind, 25.3 % in right front and 19.6% in right hind quarters (Table 14). The prevalence of SCM among the quarters did not differ

significantly (P>0.05). The highest prevalence of SCM as recorded in left hind quarter was comparable with Sudhan *et al*. (2005) and Sharma *et al*. (2007). This could be explained by the fact that the hind quarters are more exposed to dung and urine (Chakrabarti, 2007).

Fig. 15: DRAMINSKI mastitis detector

Table 13: Prevalence of subclinical mastitis in lactating cows

Variables		No. of cows tested	No. of positive cows	Prevalence (%)	Chi-square value	p-value
Age (year)	Up to 5 yrs	35	8	22.9	45.008	0.00***
	6-7 yrs	59	25	42.4		
	>7 yrs	64	54	84.4		
Milk yield (liter)	Up to 15	139	73	52.5	4.854	0.028*
	>15	19	14	73.7		
Genotype	50% HF	49	23	46.9	1.693	0.429
	62.5% HF	36	18	50.0		
	75% HF	73	46	63.0		
Parity	Up to 5	121	58	47.9	11.746	0.001***
	More than >5	37	29	78.4		
Overall		158	87	55.1		

*significant at P<0.05; **significant at P<0.01; ***significant at P<0.001;
NS= not significant (P>0.05).

10.2.3. Efficacy of Intra Mammary Infusion in lactating cows

The efficacy of IMI in lactating cows was 78.2% by using Neomastipra-JR5® in this study (Table 15). Oliver *et al*. (2004) reported 36-86% recovery of SCM in lactating cows using different antibiotic in the same route and for long duration (8 days). It would be better if organisms from SCM infected could be isolated and appropriate antibiotics used for the treatment.

Table 14: Quarter-wise prevalence of subclinical mastitis in lactating cows

	LF	LH	RF	RH	Total	x^2 value	P-value
Affected teat	51	38	40	31	160		
Prevalence	32.3%	24.1%	25.3%	19.6%	25.3%	0.213	0.09
Not affected teat	107	120	118	127	468		

LF = Left Front, LH = Left Hind, RF = Right Front and RH = Right Hind

Table 15: Efficacy of intra mammary infusion with Neomastipra-JR5

No. of cows tested	No. of cows affected with SCM	No. of cows recovered (%)
158	87	68 (78.2)

DRAMINSKI mastitis detector could be a potential candidate for the diagnosis of SCM in dairy animals in Bangladesh context. But before introducing this machine in the field it should be validated either by comparing with a gold standard test like somatic cell counter or by using latent class evaluation in a multi-test approach (Rahman *et al.,* 2010)

10.3. Effect of Non-genetic Interventions to Manage Mastitis in Dairy Cows

10.3.1. Management of mastitis incidence in HYV cows

In the baseline, 158 registered cows were tested with DRAMINSKI machine. Out of 158 cows 87 cows were found sub clinical mastitis positive. Hence, the overall prevalence of subclinical mastitis in lactating cows was 55.1%. The results of application of interventions to manage mastitis incidence are presented in Table 16.

Table 16: Results of application of interventions manage mastitis incidence in HYV cows

Treatment/ Intervention group	No. of cows (N)	Number of cows		Prevalence of SCM (%)	Chi-square value and level of significance
		Affected by SCM	Not affected by SCM		
01(Control)	158	87	71	55.1	
02	15	02	13	13.3	42.632 (P<0.01)
03	10	02	8	20	
04	10	0	10	0	
05	15	02	13	13.3	
06	18	02	16	11.11	
Overall	226	95	131	41.2	

Six different modalities and management tools were used in this study. Out of 226 lactating cows allocated in the overall experiment, 95 (41.2%) were affected by mastitis.

Treatment 1 (control) was carried out with 158 cows in several number of cow sheds. Cows were managed under traditional management. In the second treatment, floor and walls of the house were cleaned and sprayed with disinfectant Vircon –S twice a week. Out of 15 cows 2 cows in one shed were affected and 13 cows were not affected. The proportion of affected cows was 13.3%. In traditional management, valuable lactating cows of the farmers were affected by mastitis disease, resulting in severe economic losses from reduced milk production, treatment cost, increased labor and most of dairy cows were sold due to mastitis.

Sudhan and Sharma **(**2010) found that some flies spread the infection from infected cow to healthy one, particularly summer mastitis and other pathogen including *Staphylococcus aureus* from one source to the teat ends of heifers or cows. They can also develop sites for infections by biting the teat ends. Basic fly control prevents breeding of flies through routine removal of manure and decaying feeds. Smith and Hogan (1993) advocated that the animal environment should be as clean and dry as possible. The animals should have no access to manure, mud or pools of stagnant water and calving area must be clean. Cleanliness is a most important factor and plays a significant role in controlling mastitis. Controls for summer mastitis should include control of flies (particularly from July to September), use of ear tags impregnated with insecticide, sprays or pour-on preparations and avoidance of high risk pastures. Sudhan and Sharma (2010) suggested that cow shed and floor providing adequate space, ventilation, bedding, and lighting to ensure cleanliness and comfort at all times as preventive measure against mastitis. Overcrowding dung should be avoided. The key elements in the control of mastitis include: sound husbandry practices and sanitation, post milking teat dip.

In Treatment 3, calves were introduced before milking but the udder and teat were cleaned with towel which was wetted with antiseptic warm water. A sum of 10 lactating cows was considered in this case. Out of 10 cows, 2 cows (20%) were affected and 8 cows were not affected. When calves were introduced to the cow to stimulate milk let-down, teat and udder might pose lesion and pathogens might get entry into the teat. Some lesions of teat of two cows were observed and pathogens might invade the teats.

As the forced weaning is not practiced by the dairy farmers and direct calf suckling is practiced, the calf during suckling often causes surface injury on the udder and infection develops thereto. During suckling the pathogens may get entry into the teat as well. Therefore, calf suckling must be avoided at all costs in dairy animals**.**

In Treatment 4, 10 lactating cows were considered. Calves were not allowed to suckle before and after milking. In this group towel were used for cleaning the outside of the udder and teat of cows with antiseptic potassium permanganate in warm water. Calves were provided with bottle milk and milk replacer. Out of 10 lactating cows none was affected (affected percentage was 0%).

In case, where calves were introduced to stimulate milk let-down, calf sucking might cause teat and udder lesion, rupture, damage tissue and developed infection. The opening of teat might be large. During suckling the pathogens might get entry into the teat. Calf suckling avoided in this study. No lesion in or on teat was noted in this case.

Sharif and Muhammad (2009) observed that as the weaning is not practiced by most of dairy farmers in Pakistan and direct calf suckling is practiced from the dam udder, the calf during feeding often damages the udder and infection develops. During suckling the pathogens may get entry into the teat. Calf suckling must be avoided at all costs in dairy animals.

In Treatment 5, 15 milking cows constituted the group. In it cows were not exposed to touch their teat before and after two hours onto the floor. Cows were kept standing one hour before and one hour after milking because teats remains slightly open before one hour and after one hour of milking. In this case cows were supplied feed for two hours. Rice straw was preferred by the farmers to feed their animals. Out of 15 cows, 2 cows (13.3%) were affected and 13 cows were not affected.

Sharif *et al*. (2009) stated that the fundamental principle of mastitis control is that the disease is controlled by either decreasing the exposure of the teat to potential pathogens or by increasing resistance of dairy animals to infection. As, the teat canal remains open up to 2-3 h after milking to resume its normal confirmation after milking, this is the reason for providing feed and water immediately after milking to encourage animals to remain standing and the reason for having freshly

cleaned and bedded stalls when the cows do lie down. Injury to the teat muscle and/or keratin lining caused by crushing, inappropriate treatment or manipulation of the teat canal or form the development of teat end lesions associated with.

In Treatment 6, 18 cows were housed in 5 different sheds for the experiment. The floor was used by plastic mat and the mat was always washed in two times daily. Under this experiment, out of 18 cows only 2 (11.11 %) were noted to be affected. In this management tools, the used plastic mat, stagnant water, mud and manure were cleaned with clean water and the floor was dried up.

Sharif and Muhammad (2009) stressed on the pathogen-free floor conditions of the barn. Cemented/hard, smooth and dry floor is recommended for keeping dairy animals in covered areas. Soiled floor may be used for open areas in the farm. Uneven floor were harmful to the animals. During sitting and standing, the animal should feel comfortable. Similarly, dry bedding should be provided. The dung and urine should be removed immediately, as these are constant potential source of infections to the cows at the farm.

The sub clinical mastitis is characterized by no visible signs either in the udder or in the milk, but the milk production decreases and the somatic cell count (SCC) in milk increases, having greater impact in older lactating animals than in first lactation heifers. Early diagnosis of sub-clinical mastitis facilitates appropriate treatment and control. The key elements in the control of mastitis include: sound husbandry practices and sanitation, post milking teat dip, treatment of mastitis during non lactating period, and culling of chronically infected animals. *Str. agalactiae* can be eradicated from dairy herds with effective mastitis control practices, including teat dipping and dry animal therapy. *Str. agalactiae* may live almost anywhere; in the udder, rumen, feces and in the barn, they can be controlled with proper sanitation and moderately susceptible antibiotics (Sharif and Muhammad, 2009). Environmental mastitis is caused by organisms such as *E. coli* which do not normally live on the skin or in the udder but enter the teat canal when the cow comes in contact with a contaminated environment. The primary reservoir of environmental pathogens is the cow's environment, housing, bedding, etc. Incidence of environmental mastitis may occur at any time, from any source in the cow's surroundings (Sharif and Muhammad, 2009),

These findings of the research work would benefit small and medium dairy farmers particularly in the tropic and sub-tropic region. Farmers will be benefitted by using these management tools to HYV crossbred dairy cows through avoiding vaccination and treatment cost.

10.3.2. Conclusion

Farmers need suitable management tool to manage mastitis in their dairy herd. Out of six sets of management tools fourth and sixth intervention showed promising result for protecting SCM. Farmers will be benefited by using those management tools and can reduce vaccine and treatment cost to a great deal. Campaign to create awareness in this regard would be helpful for small holder peri-urban dairy farmers of Bangladesh.

10.4. Genotype-Environment Interaction in Growth Traits of Dairy Seed Calves under Semi-intensive Production System

10.4.1. Body weight of crossbred calves

The mean weight of crossbred male calves at one month, three-month, six-month and weaning period (nine-month) were 25.58, 58.20, 82.87, 181.13 kg and for females those were 25.43, 59.85, 97.38, 176.55 kg respectively (Table 17). The overall mean one month weight for male and female calves was 25.58±0.48 and 25.42±0.68 kg, respectively. Birth weight had no clear tendency to be higher in males than in females as expected and there were non-significant differences between sexes (P>0.05).

Table 17: Body weight of crossbred seed calves

Trait	Male	Female	Significance level
One month weight (kg)	25.58±0.48	25.43±0.68	NS
Three month weight (kg)	58.20±1.17	59.85±1.65	NS
Six month weight (kg)	82.87±1.93	97.38±2.72	NS
Weaning weight (kg)	181.13±15.52	176.55±19.58	NS
Average daily gain (g/d)	487.59±12.07	486.05±16.73	NS

NS = Not significant (P>0.05)

It is found that from one to six months of age the average body weight was slightly higher in female than male. But in weaning period, body weight was higher in males than females with non-significant level. But the present findings disagree with other findings where they mentioned significant difference between male and female calves growth at different ages. The negligence on male calves with feed and management over female calves might be one of the potential reasons for this deviation.

Joshi *et al.* (2001) conducted and experiment on performance evaluation of Sahiwal cattle in India. He observed that average birth weight of male and female calves were 22.35 and 20.67 kg respectively. He found male birth weight is naturally high than female, which is very much similar of this study.

10.4.2. Effect of genotype and sex of calf

The average body weight of 75% HF genotype was higher at one month to weaning (168.82±28.76 kg) period than 50% HF (128.71±23.09 kg) and 62.50% HF (138.98±21.66 kg). The average daily gain (ADG) of 75%, 62.5% and 50% HF calves from birth to weaning weight were 514.58±18.68, 510.44±14.63 and 467.45±19.80 g/d, respectively (Table 18).

Malau-Aduli *et al*. (1993) the data analyzed consisted of body weight records at birth, 3, 6,9 and 12 months of age of 549 half Friesian x Bunaii crossbred heifers collected over a twenty-five year period (1965-1989). Least squares means of body weights at birth, 3, 6, 9 and 12 months of age were 26.7±1.3, 72.4 ± 4.5, 112.9 ± 6.9, 147.2 ± 9.2 and 182.1±11.1 kg, respectively. This analyzed is very much similar of this study'

Zaman *et al*. (1983) studied the birth weight in Friesian × Sahiwal (F×S) and Jersey × Sahiwal (J×S) males was 23.73±0.25 and 19.52±0.34 kg while in females, it was 25.01±0.24 and 19.58±0.37 kg, respectively. The growth rate in F×S and J×S males at 15 months of age was 0.62 and 0.52 kg while in F×S, J×S and Friesian × Non-descript (F×ND) females; it was 0.52, 0.49 and 0.43 kg, respectively which are somewhat similar of this study.

The one month weight of Friesian-Local (75% HF), Friesian-Local (62.50% HF) and Friesian-Local (50% HF) calves were 26.52±0.75, 25.62±0.75 and 24.36±0.61 kg, respectively. Genotype had non-significant on body weight at one month *(P*<0.09), three month (*P*<0.36), six month (*P*<0.15) and at weaning (*P*<0.14) but significant effect of sex and genotype was found in E_2 (Siddiquee *et al.* 2013).

Kabir and Islam (2009) found significant difference within birth weight of calves *P*<0.01) of different genotypes of dairy cows. The highest birth weight of calves (24.14 kg), were observed in Holstein cross and lowest birth weight of calves (18.4 kg) were found in Local cows. In the present study birth weight was 24.36 kg for 50% HF calves which is very similar to the findings of Kabir and Islam (2009). Islam and Bhuiyan (1997) also found a significant (*P*<0.05) effect of genotype. The birth

weight was higher in 0.25 Pabna × SL cows (23.19±0.36 kg) than in 0.50 Pabna × SL cows (21.43±0.75 kg). The average least square mean was 23.70±2.12 kg.

Nweze *et al.* (2012) reported season, sex and breed significantly affected the birth weight ($P < 0.05$) of the two Nigerian breed and their crossbred cattle. The male calves' birth weights (14.10 kg) were superior to female (12.53 kg).The present study found in winter season birth weight is higher (26.73 kg) both male and female calves. Manzi (2011) noticed that effects of genotype, year of birth and season of birth on weaning weight were all highly significant ($P<0.001$) Weaned Friesian x Ankole calves (FA) were significantly heavier than those of all other genotypes except Brown Swiss X Ankole (BA) and Sahiwal X Ankole (SA) crossbreds. Male weaned calves (179.3 ± 6.0 kg) were heavier than female weaners (164.6 ± 9.9 kg). A wide range of weaning weight for BA and FA genotypes were observed, compared with the range of mean weights for JA, SJA, SA, and SJA suggesting that genotypes containing Jersey and Sahiwal genomes are more resilient to environment pressure. Mature weights of animals was significantly affected by genotype ($P<0.01$), sex ($P<0.001$), and year of birth ($P<0.001$) while season and its interaction with genotype ($P>0.05$) did not influence it. In present study the weaning weight was higher in summer season (186.64 kg) and it was non-significant. Also, Abera *et al.* (2012) studied breed effects, sex, year of birth and parity were the main non genetic effects that influenced birth weight (BW), weaning weight (WW), one year weight (YW), pre-weaning average daily gain (DG) and post-weaning average daily gain (PDG). Birth weight of the calves significantly ($P<0.05$) influenced by sex, where male calves were heavier than females at birth. However, female calves were superior ($P<0.05$) at weaning and one year and also had faster growth rate than male calves. In present study the birth weight, weaning weight and average daily gain of male was higher than female but it was non-significant. Sample size could be the main reason for this deviation.

Table 18: Body weight and growth of calves of various genotypes

Trait	Genotype			Significance level
	75% HF	62.5% HF	50% HF-50% Local (n=82)	
One month weight (kg)	26.52±0.75 (80)	24.37±0.62 (118)	25.63±0.75	NS
Three month weight (kg)	60.45±1.86 (82)	59.60±1.49 (118)	57.03±1.69	NS
Six month weight (kg)	85.25±2.95 (75)	84.34±2.95 (116)	85.78±3.20	NS
Weaning weight (kg)	168.82±28.76 (65)	138.98±21.66 (112)	128.71±23.09	NS
Average daily gain (g/d)	514.58±18.68	510.44±14.63	467.45±19.80	NS

NS = Not significant (P>0.05)

10.4.3. Average daily gain (ADG) from one month to weaning in two Environment systems

In poor input systems (E_1), the one month weight, three month weight, six month weight and weaning were 19.94±0.59, 53.85±1.43, 71.39±0.27 and116.93±26.03 kg respectively. In good input system (E_2) the one month weight, three month weight, six month weight and weaning are 31.07±0.58, 64.19±1.41, 98.86±2.44 and 240.75±11.18 kg respectively (Table 19). The average daily gain in E_1 and E_2 was 487.59±12.08 and 496.05±16.79 gm/day which were significantly ($P<0.001$) different and agreed well with Siddique *et al.* (2013).

The growth rates of calves from one month to weaning in present study were generally in disagreement with the report of Zaman *et al.* (1983) where the growth rate in Friesian × Sahiwal (F×S) and Jersey × Sahiwal (J×S) males at 15 months of age was 0.62 and 0.52 kg while in F×S, J×S and Friesian × Non-descript (F×ND) females; it was 0.52, 0.49 and 0.43 kg, respectively. Afroz *et al.* (2011) estimated the pre- and post-weaning growth rates which were 148.5±45.0 and 116.6±56.5 g/day, respectively in RCC Deshi cows. Addisu et *al*. (2010) found in their study growth rates for Friesian calves bred in the humid forest zone of Ghana which averaged 0.44 kg per day from one to three months, 0.27 kg per day from three to six months and 0.23 kg per day from six to nine months. An agreement with Aynalem (2006) who reported the effect of breed on daily gains of calves from birth to six months of age is somewhat similar to present study.

Gaur *et al.* (2003) observed that the body weight of male at different stages were 56.1±1.2, 87.7±3.1 and 138±52 kg at 3rd, 6th and 12th month respectively. In female animals these were 52.4±1.8, 83.9±2.4, 135.7±5.7, 241.3±8.1 and 284±53 kg at 3rd, 6th and 12th, at puberty and at first calving respectively. He also concluded that the overall mean body weight at different ages in Gir cattle were 54.0±1.1, 85.9±2.2, 137.0±4.9, 241.3±8.1 and 284.8±5.3 kg at 3rd, 6th and 12th, puberty and at first calving, respectively which is somewhat similar to present study. In this regard, Koots *et al.* (1994) and Lobo *et al.* (2000) described many of the parameters estimates for several pre-weaning and post-weaning growth traits in different beef cattle breeds from different countries.

Table19: Body weight and growth of calves in two environment systems

Trait	Poor Management (E_1)	Good Management (E_2)	Significance level
One month weight (kg)	19.94^{b}±0.59 (141)	31.07^{a}±0.58 (139)	***
Three-month weight (kg)	53.85^{b}±1.43 (141)	64.19^{a}±1.41(139)	***
Six-month weight (kg)	71.39^{b}±0.27 (141)	98.86^{a}±2.44 (139)	***
Weaning weight (kg)	116.93^{b}±26.03 (129)	240.75^{a}±11.18 (130)	***
Average daily gain (g/d)	487.59±12.08 (141)	496.05±16.79 (139)	NS

NS = Not significant (P>0.05), *** = highly significant (P<0.001)

10.4.4 Testis size and scrotal circumference

Average testis length of Friesian-Local (75% HF), Friesian-Local (62.50% HF) and Friesian - Local (50% HF) male calves at one month of age were 3.82±0.11, 3.77±0.14 and 3.76±0.14 cm respectively, at three month were 6.27±0.16, 6.24±0.13 and 6.20±0.17 cm respectively at six month were11.38±0.32, 11.13±0.25 and 11.07±0.032 cm respectively and at weaning period were13.33±0.36, 13.60±0.29 and 12.47±0.38cm respectively (Table 20). Likely, average scrotal circumference of 75% HF, 62.50% HF and 50% HF male calves at one month, three-month, six-month of age and at weaning period were 6.79±0.02, 6.72±0.14 and 6.98±0.19, 11.80±0.26, 10.29±0.19 and 10.16±0.26, 21.14±0.56, 21.11±0.41 and 18.70±0.54, 21.01±0.56, 20.11±0.41 and 18.70±0.54 cm, respectively.

Table 20: Testis length and scrotal circumference of male calves of different genotypes

Trait	Genotype			Significance level
	75% HF	62.50% HF	50% HF-50% Deshi (n=82)	
Testis length at one month (cm)	3.82±0.11 (80)	3.77±0.14 (118)	3.76±0.14	NS
Scrotal circumference at one month (cm)	6.79±0.02 (80)	6.72±0.14 (118)	6.98±0.19	NS
Testis length at three month (cm)	6.27±0.16 (80)	6.24±0.13 (118)	6.20±0.17	NS
Scrotal circumference at three month (cm)	11.80±0.26 (80)	10.29±0.19 (118)	10.16±0.26	NS
Testis length at six month (cm)	11.38±0.32 (75)	11.13±0.25 (116)	11.07±0.032	NS
Scrotal circumference six month (cm)	21.14^{a}±0.56 (75)	21.11^{a}±0.41 (116)	18.70^{b}±0.54	**
Testis length at weaning period (cm)	13.33±0.36 (65)	13.60±0.29 (112)	12.47±0.38	NS
Scrotal circumference at weaning period (cm)	21.01^{a}±0.56 (65)	20.11^{a}±0.41(112)	18.70^{b}±0.54	**

NS = Not Significant (P>0.05), ** = highly significant (P<0.01), Means with uncommon superscript along the row differ significantly (P<0.05).

The physical examination portion of a breeding soundness evaluation covers the entire body, but emphasizes feet, legs, eyes, and internal and external reproductive tract (Gosey, 1996; Sprout et al., 1998). Examination of these physical attributes seeks to ensure that a bull is capable of finding and mounting a cow in estrus (Gosey, 1996). Scrotal circumference was measured because it is an indirect measurement of potential production of spermatozoa (Latimer *et al*., 1982; Hopkins, 2003). Quality and amount of spermatozoa producing tissue within the testes can be inferred from scrotal circumference (Elmore *et al*., 1975; Brinks *et al*., 1973; Coe, 1999; Hopkins, 2003).

Lunstra *et al*. (1978) showed scrotal circumference is also a good indicator of age at which puberty is attained; as scrotal circumference increased, age of puberty decreased. Baker *et al.* (1981) Angus bulls had the largest on-test scrotal circumference measurement (27.7 cm) while the Hereford and Polled Hereford bulls had the smallest (25.6 cm). Brangus, Angus and Charolais were similar in their off-test scrotal circumference (35.2 cm) with Hereford and Polled Hereford bulls being smaller (33.3 cm). Scrotal size tended to increase at the rate of l.7 cm per month while on test. Coulter (1975) estimate the average SC ± SE by breed were Simmental, 37.7 ± 0.2 cm, Aberdeen Angus 35.6 ± 0.1 cm, Maine-Anjou 35.4±0.2 cm, Charolais 34.7 ± 0.1 cm, horned Hereford 34.6 ± 0.1 cm, Shorthorn 34.2 ± 0.2 cm, polled Hereford 34.0 ± 0.2 cm, Blonde d'Aquitaine 32.4±0.5 cm, and Limousin 32.1±0.3 cm.

Table 21 shows the effect of environment system on testis length and scrotal circumference of male calves.

Table 21: Testis length and scrotal circumference of male calves of two environment system

Trait	Poor Management (E_1) (n=141)	Good Management (E_2) (n=139)	Significance level
Testis length at one month (cm)	2.57^{b}±0.11	4.96^{a}±0.10	***
Scrotal circumference at one month (cm)	5.98^{b}±0.13	7.68^{a}±0.14	***
Testis length at three month (cm)	3.45^{b}±0.13	9.02^{a}±0.02	***
Scrotal circumference at three month (cm)	7.48^{b}±0.19	12.68^{a}±0.20	***
Testis length six month (cm)	11.05±0.25	11.34±0.24	NS
Scrotal circumference six month (cm)	17.48±0.47	18.02±0.43	NS
Testis length at weaning period (cm)	12.76±0.27	13.50±0.03	NS
Scrotal circumference at weaning period (cm)	19.81±0.40	20.16±0.43	NS

NS = Not significant ($P>0.05$), *** = highly significant ($P<0.001$)

The effect of genotype of calf and environment had no significant effect on testicular development one month, three month and six month of age and on average daily testis growth. The variation about the mean testis size includes true bull differences, seasonal effects and year of measurement effects (Coulter and Foote, 1975).

10.4.5. Survivability of calves of different genotypes in Holstein Friesian and local cross at two different environments

The present study found that in E_1 number of calves of different genotypes, such as 50% HF, 62.5% HF and 75% HF had 100%, 94.46% and 72.5% survivability respectably. Survival rate was high in 50% genotype and lowest in 75% genotype. In E2, 50% of HF had highest and 75% of HF had lowest survival rate (Table 21). In different genotypes the chi-square value of survivability was 0.027 ($P<0.05$) which was significant. In different environment, the chi- square value of survivability was 0.002 ($P<0.01$) which is highly significant (Siddiquee *et al*. 2013).

The present study found that survivability rate would decrease when Holstein inheritance is high (75% HF) whereas in E_1 there was no mortality of calves of low Holstein heritance (50% HF). Management level found to play an important role for calf mortality.

In this study, survivability was defined as the percentage of animals which remained alive for a given period of time after they were born. Survival rate of calves was measured by following formula: Survival rate = (number of calves at birth – number of calves at six month of age) / 100.

According to Amuamuta *et al.* (2006), cumulative calf mortality at 30, 180, 240 and 360 days were 3.6±0.8, 5.8±1.0, 6.5±1.2 and 9.7±1.5 %, respectively. Calf mortality rate was significantly affected ($P < 0.05$) by blood level, birth weight and sex of the calf. Season of birth and dam's parity class, on the other hand, did not seem to have a significant effect ($P > 0.05$) on calf survival probability. This study has indicated that calf mortality is a matter of serious concern in rearing

Fogera cattle under this environment and therefore suggested for a detailed study on the impact of each factors affecting calf survival.

Khan (2009) collected information on the survivability of different genotypes of dairy cattle in Bangladesh, was collected during farmer interviews and also from the literature (e.g. Shamsuddin, et al. 2006; Khan et al. 2005 and Debnath et al. 1995) and the combined results are shown in Table 22. Holstein and its crossbreds were reported to have lower survivability than Pabna and Sahiwal cattle. The causes may be genotypes × environment interactions. Similarly, low survivability of temperate breeds and their crossbreds in a tropical environment was reported by McDowell (1985) and Cunningham and Syrstad (1987) which is somewhat similar of this study. Also, Asseged (2004) conducted a study at five locations to determine the survival rate of calves and to estimate the performance level of improved dairy cows under commercialized farming systems in Ethiopia. Seven hundred and one calves born from 1997 to 1999 and 797 cows were included in the study. Cumulative calf/heifer survival at 360, 540 and 720 days was 80, 76 and 70%, respectively. This study is similar that in E_2 management 75% HF calves survivability is better than E_1.

Debnath *et al.* (1990) studied on-farm calf mortality up to 12 months of age was 9% with no clear peak mortality related to age. A higher mortality was observed in the monsoon months, in *Bos indicus/B. racti* cross-bred calves, and male vs. female calves. Malnutrition is argued to be the probable major cause of calf mortality. In this context, Vaccaro (1990) reviewed losses from birth to first calving were higher in purebred and crossbred (with zebu) animals with Brown Swiss inheritance than in those of Holstein or Jersey breeding. Purebred European cattle had higher rates of loss at all stages of life than zebus or European x zebu crosses. Best overall survival rates were recorded for the 1/2- to 5/8 European crossbreds, which produced on average 36% more surviving progeny per 100 conceptions than the purebred European cattle.

Table 22: Survivability status of calves in different environments

Parameter	Poor Management (E_1)				Good Management (E_2)				Overall
	75% HF	62.5 % HF	50% HF	Total	75% HF	62.5 % HF	50% HF	Total	
Number of calf at birth	40	56	40	136	40	62	40	142	278
No. of calf alive up to pre-weaning	35	53	40	128	29	54	34	117	245
Survivability (%)	72.5	94.64	100	94.81	87.5	87.10	100	82.39	88.13

Environment-1 = Traditional poor management, Environment-2 = Proper management, feeding and health care

10.4.6. Genotype-Environment Interaction (G x E)

a) Growth traits

The interaction effect of G×E for body weight at one month, three month, and six month of age was not significant ($P>0.05$). Moderate significant ($P<0.01$) interaction found at three month age and highly significant effect was found at six month age and average daily gain (ADG). It indicates different management system (feeding, housing) was present in two production environments which might have affected the growth performance of calves.

Macdonald *et al.* (2007) was able to evaluate the influence of genetics showed a significant difference in change of magnitude between the New Zealand 1970 birth weight (kg) (37.5 ± 1.59) and the 1990 New Zealand and North American genetics (41.9 ± 1.38 and 41.8 ± 1.30, respectively). The study also examined the difference in the three strains for yearling weight. The 1970 New Zealand, 1990 New Zealand, and 1990 North American yearling weights (kg) were 239.2 ± 3.51, 248.8 ± 2.69, 257.6 ± 2.62, respectively ($P<0.05$). Tsiokos (2010) studied the determination of any possible G×E interaction was based on the ranking correlation of the bulls breeding values, as estimated from the responsible organizations in each of the sire's origin with the corresponding breeding values estimated from the Greek dairy population. The correlation coefficients were between -0.32 and 0.45 depending on the bull's country of origin. All of them were non significant. A comparison of the mean values of the production traits in Greece and the bulls' countries of origin indicates the factors that could explain the lack of significant correlations.

In environment one (E_1) three genotypes Friesian-Local (75% HF), Friesian-Local (62.50% HF) and Friesian-Local (50% HF) showed significant interaction at one month, three month, six month age, weaning period and average daily gain, but no significant interaction found between traits of three genotypes in environment two (E_2). It indicates in environment one (E_1) calves growth performance significantly vary than E_2 due to management system.

b) Testicular development

No significant ($P>0.05$) interaction for the traits of testicular size was observed at one month, three month but significant ($P<0.02$) interaction was found at six month of age and average daily gain of Friesian - Local calves. In environment one (E_1) and environment two (E_2) three genotypes Friesian - Local (75% HF), Friesian-Local (62.50% HF) and Friesian-Local (50% HF) showed no significant interaction between traits. It meant the two production environments and genotypes have similar effect on these traits. Nuruzzaman (2012) found that the average daily testis growth of Friesian - Local (75 % HF), Friesian - Local (62.50 % HF) and Friesian - Local (50 % HF) male calves were 0.274, 0.262 and 0.210 mm / day respectively. Among the genotypes of calves higher daily growth found in Friesian - Local (75 % HF) 0.310±0.033 mm / day. The effect of calves' genotypes and environment had no significant effect on testicular development at birth, one month, three month and six month of age and on average daily testis growth.

c) Scrotal circumference

No significant ($P>0.05$) interaction was observed for scrotal circumferences at birth, one month, three month, six month of age and average daily gain. In environment one (E_1), three genotypes Friesian - Local (75% HF), Friesian - Local (62.50% HF) and Friesian - Local (50% HF) showed no significant interaction between traits but lower significant ($P<0.05$) interaction was found in E_2 for the traits of scrotal circumferences at birth, one month, three month and six month. It indicates in production environment one (E_1) different genotypes performed differently but production environment two (E_2) had no significant effect of genotypes on these traits.

Subsequent analyses of data from this study indicated that among Friesian - Local (75% HF), Friesian - Local (62.50% HF) and Friesian - Local (50% HF), Friesian - Local (75% HF) genotype performed better for all the traits in production environment two (E_2) but in production environment one (E_1) Friesian - Local (50% HF), performed better for survival, although economic analyses were not conducted in such systems. The published evidence does not support the widely held breeders' belief that a 62.50% Holstein composite is an optimal goal.

However, results normally vary for genotype by environment studies. Several studies which involved multi-state distribution of genotypes typically reported significant effects of G×E). This suggests that G×E is more prevalent in comparison across regions in production environment, while within states similar climate and management practices reduces the magnitude of G×E. The inconsistency between

regions and specific traits leads to the need for additional research to determine the effect of genotype by environment interaction.

The farmers have maintained for decades the dairy herd intermediate between *B. taurus* and *B. indicus*. Results of various surveys and census data reveal a wide variation in dairy farm size, which is associated with different genotype use; poor-input, smaller farms use a higher proportion of the more resilient, low *B. taurus* grade cows, while larger farms use more of the higher yielding, higher *B. taurus* grades.

10.4.7. Body weight and growth of calves born at different seasons

The body weight and growth was highest in winter season and the body weight and growth in three month, six month, and weaning age summer season is best (Table 23). The average daily growth was highest in summer born calves.

Table 23: Body weight and growth of calves born at different seasons

Parameter	Season of birth			Significance level
	Summer	Rainy	Winter	
Birth weight (kg)	23.82±0.81	25.97±0.66	26.73±0.64	NS
Three month weight (kg)	61.01±1.99	58.78±1.60	57.28±1.54	NS
Six month weight (kg)	85.31±3.36	83.83±2.61	82.24±2.45	NS
Weaning weight (kg)	186.64±17.10	177.97±20.31	171.90±22.81	NS
Daily weight gain (g/d)	490.54±20.58	488.61±16.14	481.31±15.49	NS

NS = Not significant (P>0.05)

However, according to Mathur and Horst (1994) a factorial analysis of variance followed by an F-test can be useful in detecting the existence of interactions, but statistical significance should not be overemphasized for biological relevance. Invariably, the magnitude of interactions can help to derive useful conclusions.

10.4.8. Conclusion

The results of the study indicate that Friesian - Local (75% HF) genotype performed significantly better in good environment (E_2) for most of the studied traits whereas Friesian - Local (50% HF) performed better in both good and poor environments (E_2 and E_1) only in survival rate meaning their suitability in respective environments. These inversely meant that Friesian - Local (75% HF) cattle in good management and Friesian - Local (50% HF) cattle in both good and poor management could be recommended for farmers' use.

10.5. Suitability of Temperate and Tropical Crossbred Dairy Cattle under Peri-urban Production System in Bangladesh

10.5.1. Age at First Heat (AFH)

Table 24 shows the least squares means of reproductive traits of Holstein-Friesian crossbred cows. Age at first heat of overall Holstein-Friesian crossbred of the present study (30.96±0.18 months) was higher than 26 months (Majid *et al*.,1995). However, AFH of intervention group (25.39±0.23 months) was similar to 25 months. Similar AFH were found in 50% HF (28.03±0.28 months) and 62.5% HF (28.69±0.25 moths). But in 75% HF, age at first heat (36.16±0.29 months) was higher than the other two genotypes. It was also evident that temperate crossbreds come into maturity at an earlier age than the breeds of tropical environment. In case of first heat, highly significant (P<0.001) genotype (G) and environment (E) interaction was observed.

Table 24: Least squares means of reproductive traits of Holstein-Friesian crossbred cows

Factors	Parameter					
	Mean ± SE					
	AFH (m)	AFC (m)	CI	DP	NSC (no)	CR (%)
Parity	-	-	NS	NS	NS	NS
1	-	-	411.51±9.86(77)	90.39^{b}±2.82(77)	1.45±0.08(089)	76.74±2.95(76)
2	-	-	397.364±8.20(116)	95.27^{b}±2.29(116)	1.51±0.06(116)	76.99±2.40(116)
3	-	-	400.28±9.23(85)	96.96^{b}±2.65(85)	1.39±0.07(85)	79.94±2.79(84)
4	-	-	400.49±19.94(22)	87.34^{bc}±5.10(22)	1.57±0.15(22)	73.20±5.53(22)
5	-	-	384.41±14.08(29)	88.87^{a}±4.52(29)	1.710±0.12(29)	69.90±4.72(29)
6+	-	-	426.144±22.58(19)	105.86^{c}±5.57(19)	1.46±0.15(19)	76.50±5.88(19)
Environment	***	***	NS	***	***	***
Intervention	25.39^{a} ±0.23(150)	34.66^{a} ±0.26(197)	394.10±7.27(150)	66.78^{a}±2.30(149)	1.38^{a} ±0.06(150)	83.56^{a}±2.41(150)
Non-intervention	36.54^{b}±0.23(198)	45.47^{b}±0.23(150)	411.79±8.68(198)	121.13^{b}±2.06(196)	1.66^{b}±0.06(200)	67.50^{b}±2.16(198)
Genotype	***	***	***	***	*	*
50% HF	28.03^{a} ±0.28(117)	37.30^{a} ±0.30(117)	378.13^{a} ±8.63(118)	88.99^{a} ±2.53(118)	1.49^{a} ±0.07(118)	74.42^{a} ±2.86(76)
62.5%HF	28.69^{a} ±0.25(131)	38.00^{a} ±0.28(131)	394.17^{a} ±8.73(131)	90.66^{a} ±2.42(131)	1.42^{a} ±0.07(133)	80.49^{a} ±2.52(88)
75%HF	36.16^{b}±0.29(99)	44.99^{b}±0.32(99)	437.80^{b}±10.53(99)	102.19^{b}±2.72(99)	1.64^{b}±0.08(099)	71.48^{b}±2.66(84)
G X E	***	***	***	***	**	*
Overall	30.96±0.18(348)	40.07±0.17(347)	403.37±6.27(348)	93.95±1.69(331)	1.52±0.05(350)	75.53±1.78(348)

Parity-calving order; Environment-based on proper feeding, Intervention-good management & health care and Non-intervention-conventional feeding and management ; Genotype-based on % of genetic material contents; G x E- interaction between genotype and environment; AFH-age at first heat; AFC-age at first calving, CI-calving interval, DP-dry period, NSC- number of services per conception; CR- conception rate; ; *-significant at 0.05 level (P<0.05); **- significant at 0.01 level (P<0.01); ***- significant at 0.001 level (P<0.001); NS- non significant (P>0.05); Figures in the parenthesis indicate the number of observation; Means with uncommon superscripts in the same column differed significantly (P<0.05).

10.5.2. Age at First Calving (AFC)

In the present study overall age at first calving (40.00±0.17 months) in HF crossbred cows was higher than the AFC in intervention group (34.66±0.26 months) and lower than the AFC in non-intervention group (45±0.47 months). However, Sarder (2006) and Islam *et al.* (2002) reported AFC in HF cross cows, which were more or less similar to intervention group. In the present study average AFC for 50%, 62.5%, and 75% HF crossbred cows were 37.30±0.30, 38.00±0.28 and 44.99±0.32 months, respectively which were higher than Rokonuzzaman *et al*.(2009) in Banglaesh (34.00±3.78 months).

10.5.3. Dry Period (DP)

In present study DP of 50%, 62.5%and 75% HF cross cows were 88.99±2.53, 90.66±2.42 and 102.19±2.72 days, respectively. Qureshi *et al*.(2002) in Pakistan found dry period of 89 days in 50 to 75% HF crossbred cows which was very close to the present findings of 50% HF crossbred cows. It was found that the effect of genotype, environment, G x E interaction on DP were highly significant (P<0.001). Early parity cows (parity 1-5) showed shorter dry period than the later (parity 6+) parity cows. The highest dry period was found at parity six+ (105.86±5.57 days) and the lowest dry period was observed at parity number four.

It is generally believed that milk yield is affected by the preceding days of dry period. Considering the biological limits and economics of the operation involved, many workers in tropical and sub-tropical regions have set a range of 40-60 days as an optimum dry period for the perspective of cow's health and farmer's profit. This also indicates that length of dry period is largely influenced by environment.

It is also seen that some managers of the farm are inclined to dry off their animals earlier to improve the herd average, while other managers go on milking the cows as long as it is affordable. Hence, emphasis should be given to select the animals on the basis of their production level and higher persistency of lactation, which should automatically lead to a decrease in dry period.

10.5.4. Calving Interval (CI)

In the present study, overall calving interval of HF crossbred cows was 403.37± 6.27 days. CI of 50%, 62.5%, and 75% HF crossbred cows were 378.13± 8.63, 394.17± 8.73 and 437.80±10.53 days, respectively. Qureshi *et al.* (2002) in Pakistan reported slightly higher calving interval (390 days) in 50% HF crossbred cows than the present study but calving intervals of 50% Friesian (F_1), 50% Friesian (F_2) and 75% Friesian (F_2) crossbred cows were 484±11.50, 514±21.63 and 515±28.28 days, respectively in Bangladesh (Majid *et al*.,1995). The effect of parity of cows on CI were non-significant (P>0.05) but the genotype and environmental interaction effect on CI were highly significant.

10.5.5. Number of Services per Conception (NSC)

The overall service per conception of HF crossbred cows was (1.52±0.05) which was similar to (1.50±0.1) Al-Amin and Nahar (2007) but higher than Hoque *et al*. (1999) (1.35±0.26). Analysis of variance showed that the number of services per conception was strongly related to the effect of the environment and its interaction with genotype (p <0.001) than the effect of genotype alone (P <0.05). The variation in services per conception might be due to different genetic make-up, nutritional status of cattle, management and failure in proper heat detection or inefficiency of inseminator.

10.5.6. Conception Rate (CR)

Conception rate is an important factor affecting herd reproduction efficiency. The overall percentage of conception rate was 75.53±1.78. The conception rate depends on different genetic and non-genetic factors as cow herself, semen quality, time of insemination, proper heat detection, efficiency of inseminator, proper feeding management etc. Though the effect of parity on CR was non-significant but the highest conception rate was found in third parity. On the contrary Islam *et al.* (2002) reported significant effect (P<0.05) of conception rate on parity. It is evident by many workers that age has significant cause of variation for conception rate and is negatively associated with reproductive performance. But in this study age/parity did not show any significant variation on conception rate that could be due to habitual delayed age at puberty in tropical cross cattle that may lead to have retained reproductive efficiency up to senility begins.

10.5.7. 180-Day Milk Yield (180DMY)

The overall milk yield of 180 days was 1463.04± 44kg (Table 25). The 180DMY was higher in 62.5%HF (1549.79±73.86kg) than 50%HF (1500.33 ±76.46 kg) and 75%HF (1339.00±75.83 kg) crossbred cow. However, Al-Amin and Nahar (2007) found the TMY in 50% HF, 1837±18 kg and in L× SL ,1362±13 kg. In this study environmental effect on 180DMY was highly significant (P<0.001). In intervention group, 180DMYwas higher than (1774.02±70.46 kg) non- intervention group (1152.06±51.13 kg). The G×E interaction was non-significant (P>0.05). The variations in milk yield between might be due to genetic make-up, lactation duration, feeding, management, environments, sample size etc.

10.5.8. Daily Milk Yield (DMY)

Average daily milk yield was 8.11±0.24 kg and the higher DMY was (8.60±0.41kg) in 62.5% HF than 50% HF (8.32±0.42kg) and 75% HF (7.42±0.42) crossbred genotypes. The DMY of intervention group (9.85±0.39kg) was higher than non-intervention group (6.38±0.28kg) and similar to Mohamed-Khair *et al.* (2007) in 50%, 62.5% and 75% HF crossbred cows.

Table 25: Least squares means of milk yield traits as affected by genotype and environment

Factor	Milk production traits (Mean±SE)	
	180 day milk yield (kg)	Daily milk yield (kg)
Genotype	NS	NS
50% HF	1500.33±76.46 (74)	8.32±0.42 (74)
62.5% HF	1549.79±73.86 (78)	8.60±0.41 (78)
75% HF	1339.00±75.83 (67)	7.42±0.42 (67)
Environment	***	***
Intervention	1774.02^{a}±70.46 (75)	9.85^{a}±0.39 (75)
Non-intervention	1152.06^{b}±51.13 (144)	6.38^{b}±0.28 (144)
G × E	NS	NS
Overall	1463.04±43.53 (219)	8.11±0.24 (219)

NS-Non-significant (P<0.05); ***-Significant (P<0.001); Figures in the parenthesis indicate the number of observation; Means with uncommon superscripts in the same column differed significantly (P<0.05); HF-Holstein-Friesian; G×E- Interaction between genotype and environment

10.5.9. Conclusion

This study indicated that the performance of 50% HF crossbred genotype were acceptable for the reproduction and 50% and 62.5% HF crossbred cows were acceptable for production under smallholder peri-urban dairying system in Bangladesh. The study concluded that the performance of available selected dairy genotypes crossbreds were favorable for the farmers.

10.6. Genetic Evaluation of Seed Calves for Growth Traits

10.6.1. Variance components and heritability

The variance components and heritability estimates for birth weight, three-month weight, six-month weight and weaning weight are presented in Table 26.

Table 26: Variance components and heritability of body weights of seed calves

Trait	N	Variance components		Heritability (h^2) ± SE
		Additive genetic	Common environment	
Birth weight (kg)	82	22.82	12.09	0.40±0.09
3- month weight (kg)	68	163.74	26.83	0.46±0.08
6- month weight (kg)	53	406.92	240.06	0.39±0.12
Weaning weight (kg)	17	1659.48	270.164	0.50±0.12

The heritability estimates for birth weight, three-month weight, six-month weight and weaning weight were 0.40±0.09, 0.46±0.08, 0.39±0.12 and 0.50±0.12, respectively. Genetic evaluation of calves for their birth weight, three-month weight, six-month weight and weaning weight were carried out using Best Linear Unbiased Prediction (BLUP) methodology. The BLUP was carried out by computer program PEST-13.4.10 (Groeneveld, 1998) to estimate breeding values of each calf for growth traits at different ages using co-variance matrices found from VCE-4.2.5 (Groeneveld, 1998) analyses. All analyses were done using a single trait animal model where animal's additive genetic effect was the only random factor and sex of calf, season of birth, genotype of calf and year of birth were considered as fixed factors. Then calves were ranked according to the predicted breeding values calculated using their pedigree and own performance. The calves were evaluated for four production traits viz. birth weight, three month weight, six month weight and weaning weight and ranked individually for each trait based on their predicted breeding value based on which selection of superior seed calves were done.

Estimated heritability of three-month, six-month and weaning weight in the present study are 0.46±0.08, 0.39±0.12 and 0.50±0.12, respectively. The increased error of h^2 estimates might be due to decreased number of observations. The results found in present study is more or less similar to the findings of Afroz *et al.* (2011)) and Rabeya *et al.* (2009) for three-month as 0.49±0.06 and 0.468; Afroz *et al.* (2011) and Rabeya *et al.* (2009) for six-month as 0.50±0.08 and 0.475; Afroz *et al.* (2011), Rabeya *et al.* (2009) and El-Saied *et al.* (2006) as 0.47±0.06, 0.467 and 0.36, respectively for weaning weight. Moderate heritability of three-month, six-month and weaning weight indicated that these traits are not much influenced by environment. So, there is scope for improvement of these traits by minimizing the environmental variation.

10.6.2. Conclusion

In conclusion, it can be pointed out that most of the traits of calves have heritability of medium value and from the breeding point of view which meant that additive gene action is playing a vital role for their expression. This work has been achieved by seeking cooperation of the farmers by opening herd Book recording system and their subsequent genetic evaluation.

10.7. Production of Certified Seed Bulls

Registered cows were inseminated with known high merit semen and a total of 82 calves (males and females) were born of which 36 were male calves and meanwhile six of them were sold along with their lactating cows. The pedigree and performance details of each and every bull calf were recorded in the maintained Herd Book. A Seed Certification Committee (Table 27) with members from Government and all other relevant stakeholders was formed and all information of the candidate bulls was placed before the committee for decision as to the suitability of them in breeding purposes. A summary of the information details of the candidate bull calves are furnished in Table 28. Out of 30 male calves (Table 28) a total of 24 promising (16 in batch one and 8 in batch two) young dairy seed bulls in two batches were certified (Figure 16) and declared suitable by the Seed Certification Committee for breeding purposes and information catalogue on the said two batches of bulls have already been passed on to the cattle breeding service providers of the country for necessary action such as acquisition and use. Table 29 below show an overall tangible results of the project.

Table 27: Seed Bull Certification Committee

Head Department of Animal Breeding & Genetics Bangladesh Agricultural University Mymensingh 2202	Convener
Director General / Representative Department of Livestock Services (DLS) Farmgate, Dhaka-1215	Member
Director General / Representative Bangladesh Livestock Research Institute (BLRI) Savar, Dhaka	Member
Deputy General Manager A.I. Enterprise, BRAC 75 Mohakhali, Dhaka	Member
Principal Scientific Officer (Animal Breeding) Savar Dairy Farm Department of Livestock Services, Savar, Dhaka	Member
Deputy General Manager (Milk Union) Milk Vita, Dhaka	Member
Principal Investigator Seed Bull Production Project Department of Animal Breeding & Genetics Bangladesh Agricultural University, Mymensingh 2202	Member Secretary

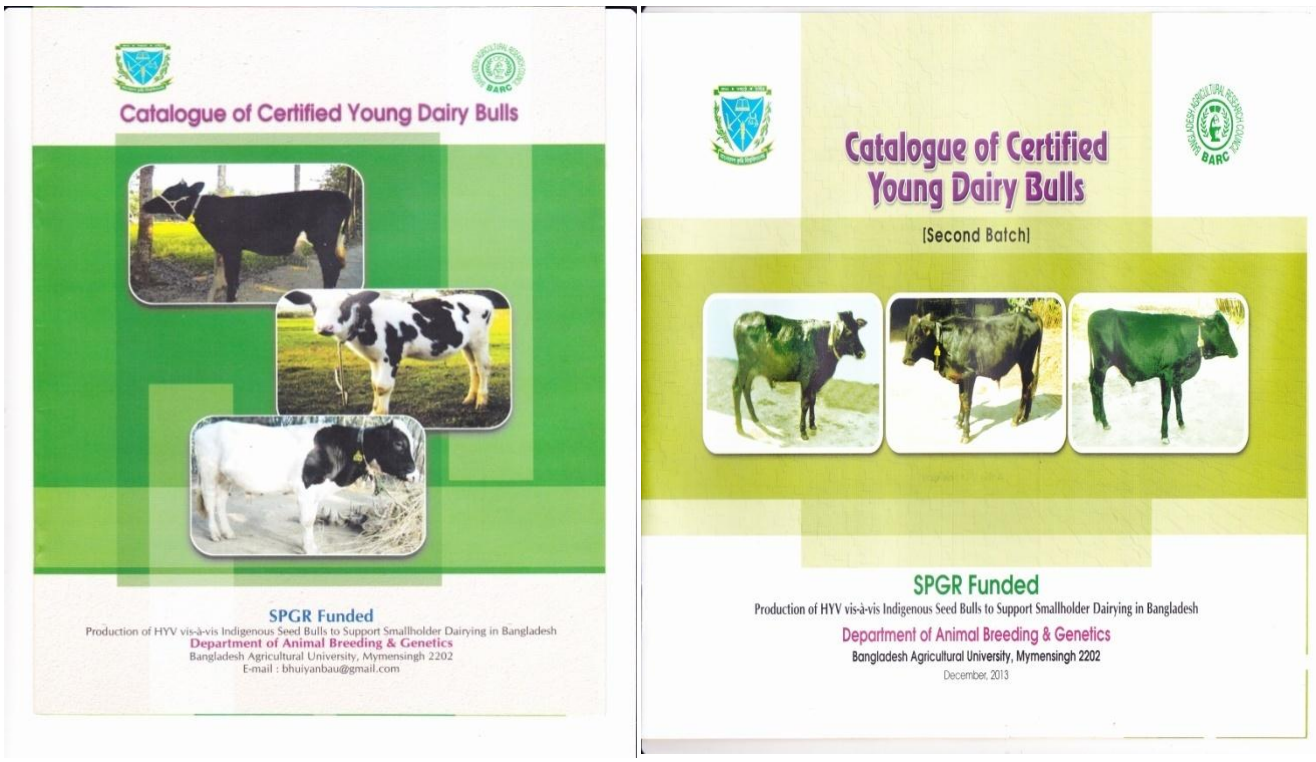

Fig. 16: Catalogue of certified young dairy seed bulls produced in two batches

Fig. 17 shows the gathering of young seed bulls in the Calf Rally and Fig. 18 shows the grown seed bulls at BAU AI Centre.

Fig. 17: Young seed bulls in the Calf Rally

Fig. 18: Grown seed bulls at BAU AI Centre

Table 28: Detailed records of candidate young dairy seed bulls

Calf ID	Date of birth	Sex	Breed	Sire ID	Dam ID	Sire's blood %	Dam's blood %	Birth wt. (kg)	3-M wt. (kg)	Dam's parity	Dam's age at puvert y (m)	Dam's daily milk yield (lit)	Paternal grand dam's daily my (lit)	No. of service	Reproducti ve trouble record of dam	Dam's mastitis test result	Dam's TB test result	Dam's Feces test result			Disease condition of calf	Remarks
																		FSS	EPG	Species		
301	02.10.11	M	75% HF	837	22	75% HF	75% HF	26	80.95	3	26	14	10	1	Normal	Free	Free				Free	Sold
302	11.10.11	M	HF-SL-D	576	112	75% HF	HF-SL-D	21	32	1	29	3.5	15	1	Normal	Free	Free	1	Nil		Free	
304	01.11.11	M	75% HF	837	98	75% HF	75% HF	24.58	64.3	7	30	14	10	1	Normal	Free	Free				Free	
307	01.12.11	M	62.5% HF	837	52	75% HF	50% HF	27.61	66.38	2	34	14	10	1	Normal	Free	Free	1	Nil		Free	
308	03.12.11	M	37.5% HF	837	51	75%H F	DES HI	27.61	59.39	15	23	4.5	10	1	Normal	Free	Free	2	300	Paramphis.	Free	Sold
309	12.11.11	M	75% HF	804	2	87.5 %HF	62.5 %HF	49.5	78.54	5	35	10.5	20	1	Normal	Free	Free					Died
310	13.11.11	M	62.5% HF	837	95	75% HF	50% HF	27	53.42	2	42	11	10	1	Normal	Free	Free				FMD	Died
311	25.11.11	M	68.75 % HF	837	92	75% HF	62.5 %HF	31	91.69	5	48	19.5	10	1	Normal	Free	Free				Free	
312	24.11.11	M	77.25 % HF	840	115	87% HF	67.5 %HF	30	55.68	4	29	8.5	14	1	Normal	Free	TB	2	Nil		Free	Sold
313	14.01.12	M	62.5% HF	837	59	75% HF	50% HF	33.15	56.39	3	27	16	10	1	Normal	Free	Free	2	Nil		Free	
316	02.02.12	M	62.5% HF	2954	44	50% HF	75% HF	39.31	94.23	1	30	12	10.5	1	Abnormal	Free	Free	1	Nil		Free	
317	20.02.12	M	75% HF	2936	53	75% HF	75% HF	40.76	59.39	3	23	22	15	1	Normal	Free	Free	2	Nil		Free	
319	28.02.12	M	62.5% HF	2936	25	75% HF	50% HF	18.94		3	25	12	15	1	Normal	Free	Free	2	Nil		FMD	Died
320	06.03.12	M	75% HF	2936	27	75% HF	75% HF	29.7	72.2	4	30	12	15	2	Normal	Free	Free	1	Nil	Fasciola	Free	
321	11.03.12	M	62.5% HF	2936	94	75% HF	50% HF	30.88 5	52.8	5	26	8	15	1	Normal	Free	Free				Free	
322	06.02.12	M	75% HF	2936	74	75% HF	75% HF	32.23	43.44	1	30	15	15	1	Normal	Free	Free				Free	

325	16.04.12	M	68.75 %HF	2936	96	75% HF	62.5 %HF	27.61	57.53	3	34	18	15	1	Abnormal(displacem ent of head)	Free	Free				Free	
326	04.05.12	M	68.75 %HF	2936	81	75% HF	62.5 %HF	30.88	78.76	1	32	12	15	1	Normal	Free	Free				Free	
328	07.08.11	M	81% HF	840	49	87% HF	75% HF	32	98.52	5	36	14	14	1	Normal	Free	Free	1	100	Paramphis.	Free	
331	02.06.12	M	68.5% HF	840	117	87% HF	50% HF	25	61.25	3	26	14	14	1	Normal	Free	Free	1	Nil		Free	
333	08.04.12	M	62.5% HF	2936	56	75% HF	50% HF	46.54	56.04	2	34	8	15	1	Normal	Free	Free				Free	
334	10.06.12	M	75% HF	2936	48	75% HF	75% HF	42.22	61.25	2	24	15	15	1	Normal	Free	Free	1	Nil		Free	
335	10.06.12	M	81% HF	840	3	87% HF	75% HF	42.22	62.83	5	28	8	14	2	Normal	Free	Free				Free	
336	16.06.12	M	68.75 %HF	2936	99	75% HF	62.5 %HF	26.5	46.54	3	37	10	15	1	Normal	Free	Free				Free	
338	02.07.12	M	74.75 % HF	840	100	87% HF	62.5 % HF	27.61	46.54	2	39	10	14	1	Normal	Free	Free				Free	
340	30.07.12	M	75% HF	502	40	75% HF	75% HF	38.18	61.25	4	41	24	22	1	Normal	Free	Free	2	Nil		Free	
342	10.08.12	M	62.5% HF	2936	152	75% HF	50% HF	29		1	38	12	15	1	Normal	Free	Free					Died
346	30.08.12	M	56.25 % HF	2954	45	50% HF	62.5 %HF	38.18		3	39	17.5	10.5	3	Normal	Free	Free	2	200	Paramphisto mum Fasciola	Free	
350	07.10.12	M	62.5% HF	2954	118	50% HF	75% HF	21.78		5	25	13	10.5	4	Normal	Free	Free	1	Nil		Free	
351	07.10.12	M	62.5% HF	2936	62	75% HF	50% HF	27.61		4	31	6	15	2	Normal	Free	Free				Free	

Table 29: Tangible results of the project

Parameter	At baseline	At the end of sub-project
Households surveyed	203 (143 had cattle and 60 had no cattle)	
Milk yield **(**lit/day)	Local:1.72±0.80 Crossbred: 6.65±5.05	
No. of registered farmers	0	62
No. of registered elite cows/heifers	0	158
No. of seed calves born from registered cows	0	82 (40 males & 42 females)
Calf mortality		Male 3.62% and female 1.21%
Incidence of mastitis	55.35 %	11.21% (SCM), 4.67% (CM)
No. of certified young dairy seed bulls produced	0	24 (1st batch : 16, 2nd batch : 8) [81.25 % HF = 3, 75% HF= 12, 74.75% HF = 1, 68.75% HF = 5, 62.5% HF = 2, 56.25% HF = 1] Additionally, 6 more seed bulls of which 2 HF, 2 Munshigonj and 2 Red Chittagong were screened (based on their mothers' milk production and reproduction records) and subsequently developed.
Average daily milk yield (lit/day)	Crossbred cows = 6.65	Dam's of certified young dairy seed bulls = 14.93

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Appendix-1: An Interview Schedule for Baseline Survey

তথ্য সংগ্রহের প্রশ্নাবলী

সীড বুল প্রোডাকশন প্রজেক্ট

পশু প্রজনন ও কৌলিবিজ্ঞান বিভাগ

বাকৃবি, ময়মনসিংহ

১। প্রাথমিক তথ্য ঃ

ক) উত্তর দাতার নাম ও সম্পর্ক ঃ.....

খ) কৃষকের নাম , ঠিকানা ও মোবাইল নম্বর---------- ঃ ..... গ্রাম/মহল্লা/পাড়া ....., ইউনিয়ন..... উপজেলাঃ ....., জেলা ঃ ময়মনসিংহ

গ) পিতার নাম ঃ

ঘ) মাতার নাম ঃ

ঙ) বসত বাড়ীর জমির পরিমান(শতক) ঃ

চ) আবাদী জমির পরিমান(শতক) ঃ

ছ) গরু পালনের অভিজ্ঞতা (বছর) ঃ

জ) পরিবারের সদস্য সংখ্যা ঃ

ঝ) মূল পেশা / অন্যান্য পেশা ঃ

ঞ) মোবাইল নম্বর ঃ

২। পরিবারের পশু-পাখির সংখ্যা ঃ

পশু-পাখি	**বয়স্ক**	**বাড়ন্ত**	**বাচ্চা**	**মোট**	**মন্তব্য**
গরু					
ছাগল					
মুরগী					
হাঁস					
অন্যান্য					

৩। গরুর ধরনঃ

		জাত ও সংখ্যা				
		খাটি বিদেশী	সংকর	দেশী	(বয়স)	মন্তব্য
ক)	দুধালো গাভী					
খ)	গর্ভবতী গাভী					
গ)	ষাড় (প্রজননক্ষম)					
ঘ)	বকনা বাছুর					
ঙ)	ষাড় বাছুর					
চ)	অন্যান্য					
	মোট					

৪। গরু পালনের উদ্দেশ্য ঃ

(ক) দুধ বিক্রি ও খাওয়ার উদ্দেশ্যে

(খ) চাষাবাদের উদ্দেশ্যে

(গ) গরু বিক্রয়ের উদ্দেশ্যে/ব্যবসা

(ঘ) শখের জন্য

(ঙ) ধর্মীয় উদ্দেশ্যে

(চ) উৎসবে

(ছ) অন্যান্য .....

৫। ক) কোন জাতের গরু বেশী পছন্দ গ ঃ .....

খ) তার কারন ঃ .....

৬। পালন প্রণালী ঃ

পালনের প্রকার	**একত্রে**	**আলাদা/এককভাবে**
গৃহে আবদ্ধ (intensive)		
ছেড়ে পালন (extensive)		
উভয়ই (semi-intensive)		

৭। খাদ্যের ধরণ ও পরিমান ঃ

	খড়		ঘাস জাতীয় খাদ্য (দেশী/ বিদেশী)	দানাদার খাদ্যের নাম	দানাদার খাদ্যের পরিমান (কেজি)
	সাধারণ	প্রক্রিয়াজাতকৃত			
গাভী					
বকন					
ষাড়					

৮। দুধ উৎপাদন ঃ

			১ম গাভী	**২য় গাভী**	**৩য় গাভী**	**৪র্থ গাভী**
ক)	গাভীর জাত	ঃ				
খ)	দুধ উৎপাদন (দৈনিক)	ঃ				
গ)	দুধ উৎপাদন কাল	ঃ				
ঘ)	গাভীর শুষ্ক অবস্থা	ঃ				
ঙ)	কত তম বাচ্চা	ঃ				
চ)	দুধ দোহনের সময় (বার)	ঃ				
ছ)	সর্বোচ্চ দুধ উৎপাদন(কেজি/দিন)	ঃ				

৯। প্রজনন বৈশিষ্ট্য ঃ

বৈশিষ্ট্য			**সংখ্যা/সময়**	**মন্তব্য**
ক)	গর্ভধারনের জন্য পালের (সার্ভিস) সংখ্যা	বকনা		
		গাভী		
খ)	১ম গরম হওয়ার বয়স (বছর)			
গ)	১ম বাচ্চা দেওয়ার সময় বয়স (বছর)			
ঙ)	বাচ্চা দেয়ার অন্তবর্তী সময় (calving interval)			
চ)	বাচ্চা দেওয়ার পরবর্তী গরম হওয়ার সময় (দিন)			
ছ)	গাভীর শুষ্ক কাল (মাস)			
জ)	গত বছরে গর্ভপাতের সংখ্যা			
ঝ)	রিটেইন্ড প্লাসেন্টা হয় কিনা?			
ঙ)	ডিস্টোকিয়া হয় কিনা?			
চ)	প্রসবের সময় গর্ভাশয় বের হয়ে আসে কিনা?			

১০। দুধের ব্যবহার ঃ

ক) নিজেদের জন্য ঃ ..... পরিমান

খ) বিক্রয়ের জন্য ঃ ..... পরিমান ।

গ) দুধ কোথায়/কিভাবে বিক্রি করেন? .....

ঘ) প্রতি কেজি/লিটার দুধের দাম কত পান?.....

ঙ) দুধের দামে খুশি কিনা? .....

চ) কোন দুগ্ধজাত পন্য তৈরি করেন কিনা ও নাম ?.....

১১। কৃত্রিম প্রজননে সমস্যা ঃ

সমস্যা	**টিক চিহ্ন**
কৃত্রিম প্রজনন কর্মী না থাকা	
মূল্য বেশী	
সময়মত কর্মী পাওয়া যায় না	

ভালমানের বীজের অভার	
গর্ভধারণ হার কম	
পারিবারিক সূত্রে কৃত্রিম প্রজনন পছন্দ না করা	
পাল প্রতি কত টাকা দিতে হয়(টাকা)	
অন্যান্য	

১২। গাভীর প্রজনন সক্ষমতা ঃ

ক্র.নং	বিবরন		১ম গাভী/ বকনা	২য় গাভী/ বকনা	৩য় গাভী/ বকনা	৪র্থ গাভী/ বকনা
ক)	গরম হওয়ার লক্ষন (প্রকাশিত/ অপ্রকাশিত)	ঃ				
খ)	পাল দেওয়ার ধরন					
	ষাঁড় দ্বারা	ঃ				
	কৃত্রিম প্রজনন (সরকারী/BRAC/বিশ্ববিদ্যালয়)	ঃ				
	উভয় (গাভী কেন্দ্রে যায় / কর্মী বাড়ীতে আসে)	ঃ				
গ)	ব্যবহৃত ষাঁড়ের জাত (দেশী /সংকর)	ঃ				
ঘ)	কৃত্রিম প্রজননে ব্যবহৃত ষাঁড়ের জাত					
	হলস্টেইন-ফ্রিজিয়ান	ঃ				
	শাহীওয়াল	ঃ				
	দেশী	ঃ				
	রেড চিটাগাং	ঃ				
	অন্যান্য	ঃ				
ঙ)	ব্যবহৃত বীজের গুনাগুন/উৎপাদন মান সম্বন্ধে কোন ধারনা আছে কি?	ঃ				

১৩। রোগ ব্যবস্থাপনা বিষয়ক তথ্য ঃ

ক) গরুকে নিয়মিত টিকা দেন কিনা? ঃ হ্যাঁ / না

খ) গরুকে কি কি টিকা দিতে হয়? ঃ বাদলা রোগ /তড়কা রোগ /খুরা রোগ /গলাফুলা রোগ

গ) বৎসরে কত বার কৃমির ঔষধ খাওয়ান ? ঃ .....

ঘ) গত ৫ বৎসরে কোন গরু মারা গিয়েছে কিনা/গেলে কয়টি? ঃ হ্যাঁ / না

ঙ) কোন রোগে বা সমস্যায় মারা গিয়েছিল? ঃ বাদলা/তড়কা/খুড়া/গলাফুলা/অন্যান্য .....

চ) অসুখ হলে কাকে ডাকেন? ঃ রেজিষ্ট্রাড পশু চিকিৎসক/গ্রাম্য হাতুড়ে ডাক্তার/ঔষধ বিক্রেতা/অন্যান্য .....

১৪। ভাল ষাঁড়ের বীজ চান কিনা? ----- হ্যাঁ / না

১৫। বীজ ষাঁড় তৈরীর কাজে গঠিত সমিতির সদস্য হতে আগ্রহী কিনা ? ..... হ্যাঁ / না

১৬। পশুপালনের উপর কোন প্রশিক্ষণ নিতে আগ্রহী কিনা ? ..... হ্যাঁ / না

প্রশিক্ষনের বিষয়.....

১৭। গত এক বছরে কত টি গরু বিক্রি করেছেন এবং মোট আয় কত ? ----------

১৮। অন্যান্য কোন গুরুত্বপূর্ণ বিষয় (যদি থাকে) .....

.....

তথ্য সংগ্রহকারীর নাম ও স্বাক্ষর

.....

Appendix 2: In-depth data collection format

Seed Bull Production Project
Department of Animal Breeding & Genetics
BAU, Mymensingh

1. Farmer's Address

Name: …… ……..…Father's name:.....
.....Village:.....……..….Union:…….Cell:…….……..

2. Cattle Status (in no. & age)

Category	Genotype 1				Genotype 2				Genotype 3				Genotype 4			
Genotype																
	No.	Age	Age	Age	No	Age	Age	Age	No.	Age	Age	Age	No	Age	Age	Age
Cow																
Heifer																
Male calf																
Female calf																
Bull																
Others																

Genotype Code: Genotype 1= Deshi, Genotype 2 = ½ H- ½ D, Genotype 3= ¾ H- ¼ D, Genotype 4= ½ SL- ½ D, Genotype 5= ¾ SL- ¼ D, Genotype 6= ½ H- ½ SL, Genotype 7= H-SL-D (any proportion) 8=62%H 9=RCC

3. Cow information

Tag. No.				
	Genotype 1	Genotype 2	Genotype 3	Genotype 4
Genotype				
Source of cow (homebred/purchased)				
Age (month)				
Calving Parity				
Breed (bull / semen) preference				
Milk production information				
Milk yield (daily basis), litre				
• Start of lactation (duration)				
• Peak of lactation (duration)				
• End of lactation (duration)				
Average daily milk yield (lit./day)				
Stage of lactation				
Highest milk production (lit./day)				
Lactation length (month)				
Dry period (day)				
Preference of cow				
Date and season of calving				

4. Feeding management for cow

Category	Cow 1	Cow 2	Cow 3	Cow 4
Straw (1=normal,2=chopped,3=soaked,4=treated)				
Frequency of concentrate feeding(1=once,2=twice)				
Amount of concentrate feeding (kg), (any thumb)				
Green grass availability (month)				
HYV grass cultivation (1=Yes,2=No)				
Feed intake (low=1, normal=2, high=3)				

5. Breeding related information

Category	Cow 1			Cow 2			Cow 3			Cow 4		
Parity	Current	Pre 1	Pre 2	Current	Pre 1	Pre 2	Current	Pre 1	Pre 2	Current	Pre 1	Pre 2
Usual breeding practice (1=NS,2=indoor AI,3= outdoor AI, 4= AI(BAU), 5= AI (Govt.)												
Date/ month of showing heat												
Age at first heat (month)												
Age at first service (month)												
Age at first calving (month)												
Calving interval (month)												
Post partum heat period (day)												
Services per conception												
Heat showing time (day/late night)												
Insemination after estrus (hour)												
No. of abortion												
No. of uterine prolapse												
No. of retained placenta												
No. of dead/abnormal calf born												

6. Disease & death status in herd

Category	Cow 1	Cow 2	Cow 3	Cow 4
Regularity of vaccination (1=Yes, 2=No)				
Name of vaccine				
Regularity of deworming (1=Yes, 2=No)				
Mastitis Occurrence in her life (no.)				
Disease occurrence in last year (1=Yes, 2=No)				
Name of disease/symptoms				
No. died in last 5 years				
Cause of death				
Age at the time of death				
Genotype of dead animals				
No. of cattle sold in last year & reason for selling				

Signature and date of survey

10. **Research Highlights**

- Practice, preference and need of dairy farmers identified
- Herd Book based effective animal recording system developed
- Mastitis mitigation protocol developed
- System for genetic evaluation of cattle developed
- Farmer participatory approach of seed bull production tested
- Young bull calves of known merit produced
- Both high yielding variety (HYV) and Indigenous seed bulls produced
- Seed bull certification system developed
- Certified seed bulls made available to breeding service providers.

A total of 24 (16 plus 8) such young dairy seed bulls in two batches were certified and declared suitable for breeding purposes by the Seed Certification Committee and information catalogue on the said two batches of bulls have already been passed on to the cattle breeding service providers (DLS, Milk Vita, BRAC, Lal Teer) of the country for necessary action. Finally, replication of Herd Book based certified dairy seed bull production work in collaboration with the said cattle breeding service providers of the country has been suggested.

11. Environment and Social Safeguard Information

There was no significant change / deterioration in environmental parameters. Rather, adoption of good practices in the farmers' houses through this sub-project created better environment, social safeguard and better income generation in their existing smallholder dairy farming system.

a) Change in Environment Situation

Sl. No.	Item	Component	Improvement / Deterioration at the start*				Improvement / Deterioration at present**				Remarks
			Small	Moderate	Large	None	Small	Moderate	Large	None	
1	Environmental issue	Flora				√				√	
		Fauna				√		+			• Awareness built about genetic erosion through farmers' training
		Genetic diversity		+				+			
		Exotic varieties				√		+			• Planned mating with semen of appropriate genotype to breed farmers ' cows
		Local varieties		+				+			
		Hybrids		+				+			
2	Soil Quality	Organic matter				√	+				• Developed farmer participatory record keeping system using Herd Book
		Chemical fertilizer				√				√	
		Soil salinity				√				√	
		Fertility status		+				+			
		Microbial activity				√				√	
		Heavy metal contamination				√				√	
		Water quality				√				√	
3	Agro-chemicals	Pesticide use				√				√	
		POP's				√				√	
		IPM				√				√	
		Pest infestation				√				√	

		Bio-pesticides				√				√	
		Health hazard				√				√	
4	Pollution	Soil				√				√	
		Water				√				√	
		Air				√				√	

b) Change in Social Safeguard Situation

At the start/before	Now/Current status	Remarks
Prevalence of high calf mortality (according to the farmers' opinion)	Reduced calf mortality	Through bio-security measures adopted, milk replacer feeding, routine preventive vaccination, deworming, veterinary support
Negligence on crossbred male calves	Careful and curious attention on male calves Attention given to grow young bull calves to sell as seed bulls to breeding service providers such as Govt., BRAC etc	• Awareness built through farmers' training • Maintaining Herd book for each animal • Cattle with known pedigree and mother's production and reproduction profile
Un-assured milk marketing system controlled by local vendors	Ensured milk marketing system with better price	Through establishing an agreement with MILK VITA to purchase milk from farmers in the project areas
Low price of their produced male calves compared to females	Value addition to their produced bull calves through "Certification"	Through certification system introduced for the Herd Book maintained cattle

13. Major Attainments *(in relation to the set objectives)*:

a. Technical: Output, Outcome and Impact

Sl. No.	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)	Impact (long term effect of the research)	Remarks
01	Benchmark survey	203 households surveyed and produced Benchmark Survey Report	Farmers' need in peri-urban dairying system identified.	Could be used in policy formulation	
02	In-depth data collection on identified elite cows and heifers	In-depth biological data (history/pedigree and performance) on 158 elite cows / heifers available, data collection tool developed	Other stakeholders would be making use of the tool	Could be applicable for developing Animal Recording System	
03	Database creation	Developed database	Potential seed	Would be	

	from in-depth data of each & every identified superior cows and heifers	on 158 elite cows /heifers	bull mothers identified	helpful for other stakeholders to use	
04	Mutually beneficial contractual agreement with elite farmers	Agreement signed with farmers	Commitment of both parties ensured	Could be used by others	
05	Animal Registration and Opening Herd Book	Herd book opened and used	Book with pedigree and performance information developed	Other breeding service providers would be able to adopt it into their breeding bull production system	
06	Milk recording	Dairy potential of registered lactating cows known	Identified potential bull mothers	Would be useful for breeding service providers	
07	Genetic evaluation of cattle	Genetic merit (breeding values) of young bulls known	System developed for genetic evaluation of cattle	Would be useful for breeding service providers	
08	Organizing animal show (Calf Rally)	Hold two Calf Rallies	Mass awareness created on the value of young bulls	Other breeding service providers may practice	
09	Training manual and profile preparation	Farmers Training Manual (in Bengali) Profile of Registered Cows (in English)	Capacity of the farmers enhanced	Other breeding service providers may practice	

b. Procurement

Sl. No	Approved provisions of Procurement (list major items)	Achievement	% of achievement	Remarks
1	Equipment: Refrigerator-1no. Neck Tags-5000 nos.	Completed	100%	Handed over to Department
	Chemicals, Reagents and Glassware	Completed	100%	Used for conducting experiments
	Furniture: Table-2 nos. Computer Table-2 nos. Chair-6 nos. Almirah-1 no.	Completed	100%	Handed over to Department

	File Cabinet-1 no.			
	Motor cycle: 1 no.	Completed	100%	Handed over to Department
	Bicycle: 2 no.	Completed	100%	Handed over to Department
	Computer, Printer and Camera: Computer-2 sets Printer-1 nos. Digital Camera-1 no.	Completed	100%	Handed over to Department
	Young seed bulls	Completed	75%	Handed over to Department
	Others			
2	Works:			
	Renovation: Semi-pucca bull shed-1 no. Bull Exerciser-1 no.	Completed	100%	Handed over to Department
	Others			
3	Services:			
	Contractual manpower: 5	Completed	100%	
	Others			

c. HRD/ Training

Title (e.g. PhD/MS/ Trainings, Workshops etc.)	Target	Attainments	No. of participants	Benefit of the higher studies/trainings	Remarks
Scientific cattle rearing in order to produce seed bull	35	35	35		
Scientific cattle rearing and Herd Book management	51	51	51		
Farmer Training-1			35		
Farmer Training-2			51		
Farmer Training-3			62		
Farmer Training-4			62		
Farmer Training-5			62		
Farmer Consultation-1			65		
Farmer Consultation-2			53		
Farmer Consultation-3			51		
Farmer Consultation-4			62		
Farmer Consultation-5			62		
Farmer Consultation-6			62		
Farmer Consultation-7			62		
Farmer Consultation-8			62		
Farmer Consultation-9			60		
Farmer Consultation-10			60		
National Workshop			51		
Seed Calf Rallies	100		123		

d. Financial

Sl. No	Major Head	Fund received (Tk.)	Expenditure (Tk.)	Balance/ Unspent (Tk.)	Remarks
01	Contractual Staff Salary	84,89,359	22,55,347	3,58,814	
02	Operating Expenses		2,71,947		
03	Fuel, Oil and Maintenance		44,203		
04	Field Research / Lab expenses and supplies		25,31,765		
05	Publications and printing		5,08,750		
06	Training/Workshop/Seminar etc.		4,80,000		
07	Capital Expenses		18,59,000		
08	Contingencies		1,79,533		
	Grand Total	84,89,359	81,30,545	3,58,814	

e. Materials developed /Publications made:

Type of material/publication	Title	Number	Remarks
Technology development	1. Animal Registration and Recording System using Herd Book 2. Cattle Genetic Evaluation System	2	
Process development	Farmer participatory system to produce seed bulls using Herd Book		
Information development	1. Incidence of mastitis on HYV crossbred dairy cows. 2. Reasons of frequent expulsion/replacement of HYV crossbred dairy cows. 3. Developed non-genetic management tools to reduce mastitis on HYV crossbred dairy cows. 4. Estimation of genotype and environment interaction of temperate and tropical crossbred dairy cattle.	4	
Journal publications	1. N.U. Siddiquee, S.M.A. Rahman, M.S.A. Bhuiyan, A.K.M. Anisur Rahman and A.K.F.H. Bhuiyan**.** 2012. Genotype-Environment Interaction in Growth Traits of Dairy Seed Calves under Semi-intensive Production System. Bangladesh Journal of Seed Science & Technology, 16 (1 &2):141-150. 2. N. U. Siddiquee, T. K.Tripura, M. T. Islam, S. A. Bhuiyan, A. K. M. A. Rahman and A. K. F. H. Bhuiyan. 2013. Prevalence of sub-clinical mastitis in high yielding crossbred cows using Draminski Mastitis Detector. Bangl. J. Vet. Med. (2013). 11 (1):41-45, ISSN: 1729-7893 (Print) 2308-0922 (Online)	4	

	3. NU Siddiquee, SMA Rahman, MSA.Bhuiyan, AKM Anisur Rahman and AKFH Bhuiyan. 2013. Practice, preference and performance of cattle under peri-urban dairy management system in Mymensingh. Bang. J. Anim. Sci. 2013. 42 (2): 89-95. 4. N.U. Siddiquee, M.S.A.Bhuiyan, A.K.M. Anisur Rahman, M.A Wadud, M. R. Amin and A.K.F.H. Bhuiyan. 2013. Effect of Non-genetic Interventions to Manage Mastitis on HYV Dairy Cows. Bangladesh Journal of Seed Science & Technology, 17 (1 & 2):29-33. 5. N.U. Siddiquee, M.A.Wadud, M.S.A Bhuiyan, A.K.M.A. Rahman, M.R. Amin and A.K.F.H. Bhuiyan. 2014. Suitability of Temperate and Tropical Crossbred Dairy Cattle under Peri-urban Production System in Bangladesh. Animal Review, 2014, 1(2):26-36. http://www.pakinsight.com/?ic=journal&journal=92.		
Books/Monographs/ Manual published	1. Registered Bull Mothers' Profile 2. Cattle Rearing Manual 3. Seed Bull Production Society Members' Catalogue Three MS and one PhD student have completed their degree with their research done under this project. MS students: 1.Evaluation of stratified dairy genotypes aiming at production of young dairy seed bulls through a farmer participatory approach- Md. Shane Khoda, Examination Roll No. 10ABGJJ-07M, Reg. No. 31386, Session: 2004-05,Semester: January-June, 2011 2.Estimation of genotype environment interaction in crossbred dairy cattle in peri-urban system of Mymensingh - Md. Nuruzzaman , Reg. No.: 32290, Session: 2005-06, Roll No.: 11ABGJJ05M, Semester: January-June, 2012 3.Genetic evaluation for growth traits of high yielding variety dairy calves -S.M. Ashiqur Rahman, Roll No. 12AHABGJD02M, Registration No. 34365 Session: 2007-08, July-December 2013 Semester PhD student: Effect of Genetic and Environmental Manipulations on the Performance of Dairy Cattle Under a Semi-intensive Management System- Nokib Ulla Siddiquee, Roll No. : 01, Reg. No: 11109, Session:	3 3 1	

	1981-'82, Department of Animal Breeding & Genetics, Bangladesh Agricultural University, Mymensingh 2202.		
Booklet/leaflet/flyer etc. published	1.Seed Bull Production Project -In English -In Bengali 2.Seed Bull to Enhance Smallholder Dairy Production	 1 1 1	
Any other			

14. Sub-project Auditing

Types of Audit	Major observations/objections raised, if any	Status at the sub-project end	Remarks
BARC	1. Laps in control over training expenses were noted. 2. Laps in control were observed with regard to advance management.		1. In the said training program, other than 51 trainees, MS and PhD students, trainers & small children of some women participants were present which we could not avoid. Hence, the number of food packets had to be increased keeping the budget under control. It was an unintentional and unavoidable mistake. In the next trainings care steps will be taken in this regard. In this circumstance, the audit authority is requested to kindly omit the audit observation. 2. It was a national and technical program for which presence of Chief Guest, Special Guest and stakeholder participation was necessary. In order to ensure their availability and kind contribution, the program could not be held earlier than scheduled date. As a result, some delay resulted in advance budget. In future such lapses with regard to advance management will be avoided. In this circumstance, the authority is requested to kindly omit the audit observation
BARC	1. Laps in control were observed with regard to advance management.		The said amount of expenses was spent for making furniture which was given to the two working farmer societies in the project areas. But the supplier failed to supply those furniture's within expected time that made delay in adjustment. The program was organized with the active participation of eminent BAU teachers, scientists and project beneficiaries. The

			advance was drawn with the verbal consent of each stockholder, but due to some unavoidable situation we were bound to change this training schedule for 2 times for maintaining quality of the program. Therefore, we were not able to implement the training program in time. In this circumstance, the audit authority is requested to kindly omit the audit observation. In future such lapses with regard to advance management will be carefully avoided.

15. Reporting

No.	Report type	Actual date of submissions	Total Numbers	Remarks
a	Inception report	18.05.10	01	
b	Monthly reports	3.8.10,3.8.10,3.8.10,13.10.10,13.10.10, 8.11.10,5.12.10, 6.1.11, 7.2.11,7.3.11,10.4.11, 4.5.11,2.6.11,11.7.11,7.8.11,11.9.11,19.10.11,13.11.11,7.12.11,3.1.12,6.2.12,6.3.12,5.4.12,13.5.12,6.6.12 8.7.12,12.812,6.9.12,16.10.12,7.11.12,9.12.12,6.1.13,10.2.13,4.3.13,10.04.13,20.5.13,23.6.13,18.7.13, 22.8.13,14.11.13,14.11.13,14.11.13,12.12.13,30.1.14	43	
c	Statement of expenditures (SoE)	3.8.10,3.8.10,3.8.10,13.10.10,13.10.10,8.11.10,5.12.10,6.1.11,7.2.11,7.3.11,10.4.11,4.5.11,2.6.11,11.7.11,7.8.11,11.9.11,19.10.11,13.11.11,7.12.11,3.1.12,6.2.12,6.3.12,5.4.12,13.5.12,6.6.12,8.7.12,12.812,6.9.12,16.10.12,7.11.12,,9.12.12,6.1.13,10.2.13,4.3.13,10.04.13,20.5.13,23.6.13,18.7.13,22.8.13,14.11.13,14.11.13,14.11.13,12.12.13,30.1.14	43	
d	Quarterly reports	3.8.10,6.1.11,10.4.11,11.7.11,19.10.11,3.1.12,5.4.12,8.7.12,16.10.12,6.1.13,10.4.13,18.7.13,14.11.13, 30.1.14	13	
e	Six monthly reports	6.1.11,11.7.11,19.10.11,5.4.12,16.10.12,10.4.13, 14.11.13	7	
f	Procurement plan	01.05.10	1	
g	Annual research program format	25.4.11,31.3.12,5.10.13	3	
h	Environmental monitoring	04.03.13	1	
i	Social safeguard status	12.11.12	1	
j	Field Monitoring reports	4.2.11,13.9.11,2.1.12,18.4.12	4	

16. Problems /Contraints (Bullet points- max. 5 nos.) :

- Loss of sample size due to selling of farmers' cows as and when their financial need arises was a reality (and limitation) in this type of farmer-participatory approach.
- Due to unavoidable reason some of the activities of the sub-project could not well be accomplished.

17. Suggestion for future, if any :

Replication of this research and development work by cattle breeding service providers (Government, BRAC, Lal Teer) of Bangladesh in different milk-shed areas of the country is suggested.

Acknowledgement

On behalf of the project team I sincerely acknowledge the financial support of SPGR, Bangladesh Agricultural Research Council (BARC) to develop a Herd Book based system for producing seed bulls to support smallholder dairying in Bangladesh. I gratefully acknowledge the support of team members, graduate students, departmental colleagues, BAURES and project staff for their all out support in accomplishing the project. Finally, heartfelt thanks and appreciation to selected dairy farmers of the project sites for their immense cooperation and participation.

Signature of the Coordinator/Principal Investigator (as applicable)

30/4/2014

Prof. Dr. A.K. Fazlul Haque Bhuiyan
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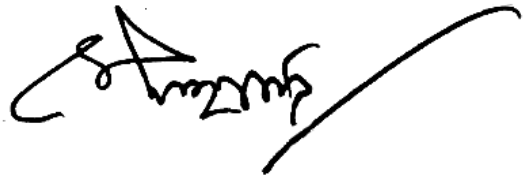
Seed Bull Production Project
Dept. of Animal Breeding & Genetics
BAU, Mymensingh.

Date …….



Counter signature of the Head of the agency/authorized representative

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